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**TITLE: 6TH ANNUAL TRAUMA ANESTHESIA AND CRITICAL CARE
SYMPOSIUM (20-23 MAY 1993)**

PRINCIPAL INVESTIGATOR: Christopher M. Grande, M.D.

**CONTRACTING ORGANIZATION: The International Trauma Anesthesia
and Critical Care Society (ITACCS)
P.O. Box 4826
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**PREPARED FOR: U.S. Army Medical Research and
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Frederick, Maryland 21702-5012**

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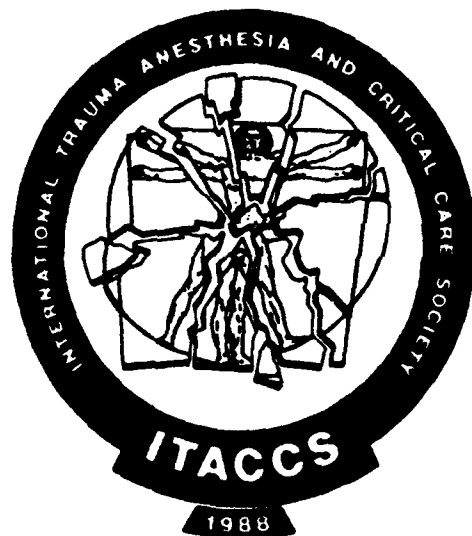
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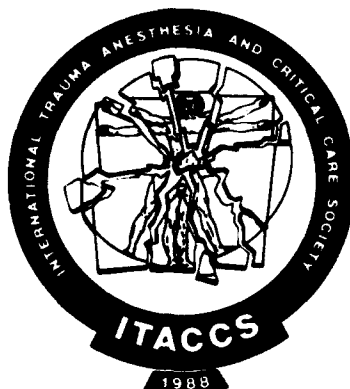
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6th Annual Trauma Anesthesia and Critical Care Symposium

May 20-23, 1993 • Baltimore, Maryland

WEDNESDAY, MAY 19, 1993

5:00-7:00 P.M. Pre-Registration – Hyatt Regency Baltimore

THURSDAY, MAY 20, 1993

7:00 A.M. Registration and Continental Breakfast

7:30 A.M. Welcome and Introduction
Christopher M. Grande, MD

PLENARY SESSION 1: General Topics in Trauma Anesthesia

Moderator: Adolph H. Giesecke, MD

7:45 A.M. Major Issues in Trauma: 1993
Adolph H. Giesecke, MD

8:15 A.M. The History of Trauma Anesthesia
David J. Wilkinson, MBBS, FRCAnaes

9:00 A.M. Organization of Trauma Anesthesia Services
Kenneth J. Abrams, MD

9:30 A.M. Impact of Drugs and Alcohol on Morbidity, Mortality, and Anesthetic Care of the Traumatized Patient
Michael J. A. Parr, MBBS, MRCP, FRCAnaes

10:00 A.M. Discussion

10:15 A.M. BREAK

10:30 A.M. Medicolegal Issues in Trauma Anesthesia
William H. L. Dornette, MD, JD

11:15 A.M. Continuous Quality Improvement for Trauma Anesthesia
Brian G. McArary, MD

PLENARY SESSION 2: Pharmacology in Trauma Anesthesia

Moderator: Leo H. D. J. Booij, MD, PhD, FRCAnaes

11:45 A.M. Muscle Relaxants
Leo H. D. J. Booij, MD, PhD, FRCAnaes

12:15 P.M. Intravenous Agents
Levon M. Capan, MD

12:45 P.M. Inhalation Agents
Levon M. Capan, MD

1:15 P.M. Discussion

1:30 P.M. Lunch (on your own) – Visit Harborplace and the Gallery
Exhibits Open

PLENARY SESSION 3: Forum on Pain Management for Trauma

Moderator: David P. Taratino, MD

3:00 P.M. Pathophysiologic Responses to Pain After Injury
Leo H. D. J. Booij, MD, PhD, FRCAnaes

3:30 P.M. Systemically Administered Agents
T. James Gallagher, MD, FCCP, FCCM

DID YOU KNOW THAT MANY EMS SYSTEMS REQUIRE THAT PROFESSIONALS WHO MANAGE TRAUMA OBTAIN AS MANY AS 20 CREDIT HOURS ANNUALLY AND SPECIFICALLY IN TRAUMA?

THURSDAY, MAY 20, 1993 (continued)

- 4:00 P.M. Invasive Pain Control Techniques
David P. Tarantino, MD
- 4:30 P.M. Panel Discussion and Case Presentations
David P. Tarantino, MD
- 5:00 P.M. Break – Visit Exhibits

PLENARY SESSION 4: Forum on Trauma Anesthesia Research – Historical Overview and Sources of Funding

This session will present a view from several investigators in the area of trauma. Specifically to be reviewed are the motivation and forces supporting the previous consensus conferences on trauma and the recent role of the Centers for Disease Control. Sources of funding solicited from the public, federal authority, and military sources, will also be reviewed, as well as the type of research funded and a compilation of data on outcome.

- 5:30-7:10 P.M. Moderator: *Enrico M. Camporesi, MD*
Panelists: *Dean E. Calcagni, MD*
Ronald G. Pearl, MD, PhD
Timothy G. Buchman, MD, PhD, FACS, FCCM
Bruce F. Cullen, MD
- 7:10 P.M. Discussion
Enrico M. Camporesi, MD
- 7:30 P.M. Day's Adjournment
- 8:00 P.M. ITACCS Board Meeting

FRIDAY, MAY 21, 1993

- 7:00 A.M. Registration and Continental Breakfast – Visit Exhibits
- 7:30 A.M.-
12:15 P.M. **SIMULTANEOUS BREAKAWAY SESSIONS**
- 9:30 A.M. Break – Visit Exhibits
- 10:00 A.M. Simultaneous Sessions Continue
- 12:15 P.M. Lunch (on your own) – Visit Harborplace and the Gallery

SIMULTANEOUS SESSION I. Special Techniques and Equipment for Trauma Anesthesia

This session will begin with didactic presentations of special techniques for trauma anesthesia in the field, desirable safety features of anesthesia equipment, features of field anesthesia machines, and other portable anesthesia apparatus such as ventilators. The second half will involve practical "hands-on" demonstrations of available anesthesia equipment. In addition to the anesthesia equipment experts, representatives from each manufacturer will be available to address technical issues.

Moderator: *William Clayton Petty, MD*
Panelists: *Brian F. Condon, MD*
Leland H. Hanowell, MD
Charles P. Kingsley, MD
Colin A. B. McLaren, MB ChB, FRCAnaes
John Restall, MB, BS, FRCAnaes

SIMULTANEOUS SESSION II. Pediatric Trauma Anesthesia

The pediatric trauma patient presents unique problems. Specific aspects of the management of closed head injury, initial resuscitation, and transport of the injured child will be presented. Additionally, a "hands-on" mini-session on intraosseous infusion will be presented.

Moderator: *Aleksandra Mazurek, MD*

Past and Future of Pediatric Trauma: The Role of the Anesthesiologist and Adult Surgeon in the Care of Pediatric Trauma Victims
J. Michael Badgewell, MD

Pain Management in Pediatric Trauma Victims
Armin Rieger, MD

LET ITACCS HELP YOU MEET YOUR COMMITMENT!!!

Transport of the Critically Injured Child
Philippe-Gabriel Meyer, MD

Procedures in Pediatric Life Support
Myron Yaster, MD

Round Table – Prehospital Care of an Injured Child

Moderator: Aleksandra Mazurek, MD

Panelists: J. Michael Badgewell, MD

Jeffrey M. Berman, MD

Steven C. Hall, MD, FAAP

Philippe-Gabriel Meyer, MD

Linda Jo Rice, MD, MC USNR

Armin Rieger, MD

Myron Yaster, MD

Intraosseous Infusion Introduction

Jeffrey M. Berman, MD

Intraosseous Infusion Workshop

SIMULTANEOUS SESSION III. Level One Trauma Anesthesia Simulations (LOTAS)

This session will follow a trauma patient from the field to discharge from the operating room using real video tapes to illustrate patient management protocols, stressors, decision-making, errors and real-life events associated with resuscitation and anesthesia for trauma. The equipment used will be described and video analysis techniques discussed.

Moderator-in-Chief: Colin F. Mackenzie, MD

Field Video Tapes

Yoel Donchin, MD

Transport Video Tapes

Yoel Donchin, MD

Frances Forrest, MD

Resuscitation Video Tapes

Colin F. Mackenzie, MD

Operating Room Video Tapes

Colin F. Mackenzie, MD

Frances Forrest, MD

Effects of Fatigue and Experience on Performance

David Gaba, MD

Analysis of Audio Communications

Richard Horst, PhD

Setting Up a Video Acquisition and Analysis System

Colin F. Mackenzie, MD

SIMULTANEOUS SESSION IV. Trauma Anesthesia Research: Scientific Posters

During this session participants will be available to discuss their posters. An award will be given for the best presentation. The presentations will be judged on the basis of content, scientific content, and artistic effort.

Moderator-in-Chief: Enrico M. Camporesi, MD

Moderators: Pierre A. Carli, MD

Levon M. Capan, MD

Bruce F. Cullen, MD

Adolph H. Giesecke, MD

Ronald G. Pearl, MD, PhD

SIMULTANEOUS SESSION V. Special CRNA Session: Part I

This special session for CRNAs (as well as interested physician anesthesiologists) has been developed by CRNAs who are actively involved in the MIEMSS and other outstanding trauma centers to address major issues in providing critical care anesthesia skills for seriously injured trauma patients. The topics addressed will give practical information on resuscitation, stabilization, and appropriate anesthesia care delivery to complement the main symposium program material. While the main symposium program will provide a comprehensive conceptual framework, this session emphasizes the practical skills needed in the care of trauma patients.

FRIDAY, MAY 21, 1993 (continued)

Moderator: Charles R. Barton, CRNA, MEd

Initial Assessment of the Trauma Patient
Christopher Romanowski, CRNA

Lessons Learned in Trauma Anesthesia
John Connelly, CRNA

Mechanisms of Injury in Trauma
Cynthia Roy, CRNA, BSN

Anesthetic Management of the Spinal Cord Injured Patient
Charles R. Barton, CRNA, MEd

Use of Fiberoptics in Airway Management
Delores A. Donnelly, CRNA, BS

Panel Discussion

SIMULTANEOUS SESSION VI. Trauma Anesthesia Research: Scientific Free Papers: Part I

During this session participants will give brief oral presentations using slides of scientific material related to trauma anesthesia and critical care. An award will be given for the best presentation. Presentations will be chosen on the basis of scientific merit and content.

Moderator-in-Chief: Enrico M. Camporesi, MD

*Moderators: Pierre A. Carli, MD
Levon M. Capan, MD
Bruce F. Cullen, MD
Adolph H. Giesecke, MD
Colin F. Mackenzie, MD
Ronald G. Pearl, MD, PhD*

AFTERNOON

PLENARY SESSION 5: PreAnesthetic Preparation of the Trauma Patient

Moderator: Kenneth J. Abrams, MD

- 1:30 P.M. Pre-anesthetic Evaluation of the Trauma Patient
Kenneth J. Abrams, MD
- 2:00 P.M. Diagnostic Imaging: Implications for the Trauma Anesthesiologist
Susan G. Kaplan, MD
- 2:30 P.M. Monitoring for Trauma Anesthesia
Ruby M. Padolina, MD
- 3:00 P.M. Discussion
- 3:15 P.M. Break – Visit Exhibits

PLENARY SESSION 6: Perioperative Anesthetic Management of Patients with Injured Organ Systems: Part I

Moderator: Yves Lambert, MD

- 3:45 P.M. Perioperative Anesthetic Management of Burn Trauma
Bruce F. Cullen, MD
- 4:15 P.M. Smoke Inhalation
Yves Lambert, MD
- 4:45 P.M. Perioperative Anesthetic Management of Orthopedic Trauma
Andrew D. Rosenberg, MD
- 5:15 P.M. Discussion
- 5:30 P.M. Break – Visit Exhibits

PLENARY SESSION 7: Perioperative Anesthetic Management of Patients with Injured Organ Systems: Part II

Moderator: Leland H. Hanowell, MD

- 5:45 P.M. Fat Embolism as a Complication of Trauma
Anne J. Sutcliffe, BSc, MB ChB, FFARCS, ARPS

FRIDAY, MAY 21, 1993 (continued)

6:15 P.M.	Perioperative Anesthetic Management of Obstetric Trauma <i>Robin L. Prentice-Berkseth, MD</i>
6:45 P.M.	Perioperative Anesthetic Management of Thoracoabdominal Trauma <i>Leland H. Hanowell, MD</i>
7:15 P.M.	Discussion
7:30 P.M.	Day's Adjournment
8:00 P.M.	Reception

SATURDAY, MAY 22, 1993

7:00 A.M.	Registration and Continental Breakfast
7:30 A.M.	SIMULTANEOUS BREAKAWAY SESSIONS
12:00 Noon	
9:30 A.M.	Break – Visit Exhibits
10:00 A.M.	Simultaneous Sessions Continue
12:00 Noon	Lunch (on your own) – Visit Harborplace and the Gallery

SIMULTANEOUS SESSION I. Difficult Airway Management for the Trauma Patient

This session will begin with representative case presentations of controversial issues such as shotgun wounds of the face, facial fractures, the "wired jaw," spinal ankylosis, laryngeal injury, penetrating neck wounds, tracheostomies, intrathoracic airway trauma, and the use of special management techniques. Audience participation is emphasized in the form of questions and answers and commentary dialogue. The second portion of the session will feature "hands-on" skill stations such as fiberoptic intubation procedures, protection of cervical spine injury, and performing cricothyroidotomy.

*Moderators-in-Chief: Kenneth J. Abrams, MD
Elizabeth C. Behringer, MD*

*Panelists: Kenneth J. Abrams, MD
Bullard Laryngoscope, Cricothyroidotomy*

*Elizabeth C. Behringer, MD
Lung Separation Techniques: Double Lumen Tubes, Univent Tube*

*Charles R. Barton, CRNA, MEd
Augustine Guide, Nasal Intubation*

*Leland H. Hanowell, MD
Fiberoptic Intubation*

*Roger S. Cicala, MD
Airway Injuries*

*Adolph H. Giesecke, MD
Aspiration Prophylaxis/Combitube*

*Lynette J. Mark, MD
Difficult Airway/Intubation Alert*

*Vijayalakshmi U. Patil, MD
Magnetic Intubation*

*John K. Stene, MD, PhD
BAAM, MIAT, Cricoid Pressure*

*Anne J. Sutcliffe, BSc, MB ChB, FFARCS, ARPS
Laryngeal Mask Airway*

SIMULTANEOUS SESSION II. Trauma Anesthesia for Disasters

This session will begin with short didactic presentations of basic principles of anesthesia under extreme conditions. Then, beginning with an explanation of the "rules of engagement," members of the audience will be assigned various roles that they will assume during the "simulations." The simulations will include combined mass casualty/disaster/military situations and will focus on evaluation of individual and team performance under stressful conditions.

Moderator-in-Chief: Vladimir Kvetan, MD

Panelists: Yoel Donchin, MD

J. Alexander Hunter, MBBS, MRCP, FRCAnaes

Nachshon Knoler, MD

Marzio G. Mezzetti, MD, PhD

T. Michael Moles, MBBS, FFARCS, DTMH

Michael Olds, PA-C, NREMT-P

Michael J. A. Parr, MBBS, MRCP, FRCAnaes

PART 1: DIDACTIC PRESENTATIONS

Overview of Disaster Epidemiology and Response (ECF 8 and ECF 9)

Vladimir Kvetan, MD

Modifications of Standard Trauma Anesthesia/Critical Care Protocols for Disasters

Marzio G. Mezzetti, MD, PhD

Civilian Mass Casualty Incidents: Implications for Anesthesia/Critical Care Services

T. Michael Moles, MBBS, FFARCS, DTMH

Clinical Trauma Anesthesia/Critical Care Specialist Approach and Use of Non-Anesthesia Personnel

Yoel Donchin, MD

PART 2: SIMULATION

Yoel Donchin, MD and Panelists

SIMULTANEOUS SESSION III. Trauma Anesthesia Research: Scientific Free Papers: Part II

During this session participants will give brief oral presentations using slides of scientific material related to trauma anesthesia and critical care. An award will be given for the best presentation. Presentations will be chosen on the basis of scientific merit and content.

Moderator-in-Chief: Enrico M. Camporesi, MD

Moderators: Pierre A. Carli, MD

Levon M. Capan, MD

Bruce F. Cullen, MD

Adolph H. Giesecke, MD

Colin F. Mackenzie, MD

Ronald G. Pearl, MD, PhD

SIMULTANEOUS SESSION IV. Special CRNA Session: Part II

This special session for CRNAs (as well as interested physician anesthesiologists) has been developed by CRNAs who are actively involved in the MIEMSS and other outstanding trauma centers to address major issues in providing critical care anesthesia skills for seriously injured trauma patients. The topics addressed will give practical information on resuscitation, stabilization, and appropriate anesthesia care delivery to complement the main symposium program material. While the main symposium program will provide a comprehensive conceptual framework, this session emphasizes the practical skills needed in the care of trauma patients.

Moderator-in-Chief: Charles R. Barton, CRNA, MEd

New Concepts in Pain Management of Trauma Patients

Russell Baker, CRNA, MS

Neurological Evaluation of the Trauma Patient

Robert Akins, CRNA, BS

Fluid Resuscitation of the Trauma Patient – Part I

Mark Kossick, CRNA, MS

Fluid Resuscitation of the Trauma Patient – Part II

Mark Kossick, CRNA, MS

Anesthetic Management of the Patient Sustaining Abdominal Trauma

Patricia Taub, CRNA, BS

Anesthetic Management of the Pregnant Trauma Patient

Charles R. Barton, CRNA, MEd

Anesthetic Management of Severe Maxillofacial Injuries

Robert Akins, CRNA, BS

SATURDAY, MAY 22, 1993 (continued)

AFTERNOON

PLENARY SESSION 8: Forum on Prehospital Trauma Anesthesia

Moderator: Wolfgang F. Dick, MD, PhD, FFARCS (Hon)

- 1:15 P.M. Efficacy of Prehospital Measures in Trauma Patients
Wolfgang F. Dick, MD, PhD, FFARCS (Hon)
- 1:45 P.M. Role of the Trauma Anesthesiologist: Diagnostics From the Field Through to the ICU
Margaret Hemmer, MD
- 2:15 P.M. Controversies with Medical Antishock Trousers in Trauma
Bruno Riou, MD
- 2:45 P.M. Anesthesiologists in the Field: The Berlin Experience
Armin Rieger, MD
- 3:15 P.M. Anesthesia and Critical Care in the Field and During Transport
Pierre A. Carli, MD
- 3:45 P.M. Discussion
- 4:00 P.M. Break

PLENARY SESSION 9: Forum on Neurotrauma

Moderator: Elizabeth A.M. Frost, MD

- 4:15 P.M. Perioperative Anesthetic Management of Maxillofacial Trauma
Alexander W. Gotta, MD
- 4:45 P.M. Physiologic Considerations in the Management of Acute Head Injury
Donald S. Prough, MD
- 5:15 P.M. Non-Neurosurgical Complications of Severe Head Trauma
Margaret Hemmer, MD
- 5:45 P.M. Perioperative Anesthetic Management of Severe Head Trauma
Elizabeth A.M. Frost, MD
- 6:15 P.M. Measurement of Brain Tissue Oxygenation with Near Infrared Spectroscopy
Kazuo Okada, MD
- 6:45 P.M. Discussion
- 7:00 P.M. Day's Adjournment
- 7:30 P.M. ITACCS General Membership Meeting

SUNDAY, MAY 23, 1993

- 7:00 A.M. Registration and Continental Breakfast

PLENARY SESSION 10: Complications of Trauma and Trauma Anesthesia

Moderator: Ake N. A. Grenvik, MD, PhD

- 7:30 A.M. Impact of Hemoglobinopathies on the Perioperative Anesthetic Management of Trauma
Michael E. Bearb, MD, FACA
- 8:00 A.M. Bleeding and Thrombosis
Charles W. Whitten, MD
- 8:30 A.M. Cardiovascular Complications of Severe Trauma
Philip D. Lumb, MB, BS, FCCM
- 9:00 A.M. Pulmonary Complications of Severe Trauma
Anne J. Sutcliffe, BSc, MB ChB, FFARCS, ARPS
- 9:30 A.M. When Your Trauma Patient Dies: Failed Resuscitation, Brain Death, Organ Salvage, and Transplantation
Ake N.A. Grenvik, MD, PhD
- 10:00 A.M. Discussion
- 10:15 A.M. Break

SUNDAY, MAY 23, 1993 (continued)

PLENARY SESSION 11: Issues in Perioperative Critical Care of Trauma Patients

Moderator: John K. Stene, MD, PhD

- | | |
|------------|---|
| 10:30 A.M. | Ergonomics of Trauma Anesthesia
<i>Yoel Donchin, MD</i> |
| 11:00 A.M. | Near Drowning: Implications for the Anesthesiologist
<i>Elizabeth C. Behringer, MD</i> |
| 11:30 A.M. | Gastrointestinal Complications in the Critically Ill and Injured
<i>Susan L. Goelzer, MD</i> |
| 12:00 Noon | Sepsis and Multiple Organ Failure in the Trauma Patient
<i>Ronald G. Pearl, MD, PhD</i> |
| 12:30 P.M. | Acute/Chronic Renal Failure
<i>John K. Stene, MD, PhD</i> |
| 1:00 P.M. | Update on the Use of ECMO for Trauma
<i>Michael T. Snider, MD, PhD</i> |
| 1:30 P.M. | Discussion |
| 1:45 P.M. | Conference Adjournment |
| 2:00 P.M. | Tour - R Adams Cowley Shock Trauma Center |

PLENARY SESSION 1:
General Topics in Trauma Anesthesia

Moderator: Adolph H. Giesecke, MD

Major Issues in Trauma: 1993
Adolph H. Giesecke, MD

The History of Trauma Anesthesia
David J. Wilkinson, MBBS, FRCAnaes

Organization of Trauma Anesthesia Services
Kenneth J. Abrams, MD

*Impact of Drugs and Alcohol on Morbidity, Mortality, and
Anesthetic Care of the Traumatized Patient*
Michael J. A. Parr, MBBS, MRCP, FRCAnaes

Discussion

Medicolegal Issues in Trauma Anesthesia
William H. L. Dornette, MD, JD

Continuous Quality Improvement for Trauma Anesthesia
Brian G. McAlary, MD

MAJOR ISSUES IN TRAUMA ANESTHESIA: 1993

Adolph H. Giesecke, M.D.

I. The Challenge of Trauma Anesthesia in 1993

- A. Mounting Violence in the World and in the USA.**
- B. Expanding Role of the "Trauma Anesthesiologist".**
- C. Progressive Cooperation Between Trauma Anesthesia and Critical Care Medicine**
- D. US Health Care Reform and Trauma Care**

II. The Challenge of Drug Abuse in Trauma Anesthesia

III. The Challenge of Blood Conservation in Trauma Anesthesia

IV. The Role of ITACCS in Meeting These Challenges

- A. ITACCS Newsletter now Affiliated with ANESTHESIOLOGY NEWS**
- B. Anesthesia and Analgesia recognizes Trauma.**
- C. ITACCS and ASTA (American Society of Trauma Anesthesiologists).**
 - 1. Bi-annual Meeting Series ("Trauma Anesthesia 'XX, 19XX Trauma Anesthesia Update, featuring Difficult Airway Management for Trauma and Pediatric Trauma Anesthesia Workshops)**
- D. ITACCS National Meetings Outside the USA**
 - 1. ITACCS - Belgium: Leuven, December 3-5, 1992**
 - 2. ITACCS - UK: London, May 6, 1993**
 - 3. ITACCS - Chile: Santiago, June 14-19, 1993**

4. ITACCS - Germany: Berlin, November, 1993
5. ITACCS - Italy: Milan, December, 1993
6. ITACCS - India: Delhi, February, 1994
7. ITACCS - France: Paris, April 1994

E. ITACCS support of other Anesthesia Associations

1. ASA - Washington, D.C., October 1993 - Trauma Anesthesia Panel
2. Royal College of Anesthesiologists of Thailand - Hosting 9th Asian Anesthesia Congress of Anaesthesists - Bangkok, 1994 - Trauma Anesthesia Panel,
3. WFSA European Section, Tel Aviv 1994, Trauma Anesthesia Panel

F. Research in Trauma Anesthesia: ITACCS Grants for Retrospective and Prospective Studies (plans for expansion)

G. ITACCS Publications:

1. Overview of Trauma Anesthesia and Critical Care, Critical Care Clinics, Vol 6, No 1, WB Saunders Co., Philadelphia, 1990
2. "Trauma Anesthesia" (a 510-page, introductory-level textbook, sponsored by ITACCS, was published by Williams and Wilkins in 1991)
3. "Textbook of Trauma Anesthesia and Critical Care" (a comprehensive, 1445-page reference text with over 125 contributors and chapters, sponsored by

ITACCS was published by Mosby-Year Book in late 1992).

4. Pediatric Trauma Anesthesia, International Anesthesiology Clinics, Vol. 32, No. 1, Boston, Little Brown Co., 1994, in progress.
5. Perioperative Anesthetic Management of Neurotrauma, Problems in Anesthesia, Vol. 8. No. 3, Philadelphia, JB Lippincott, 1994, in progress
6. Trauma Anesthesia and Critical Care in Thoracic Injury, Seminars in Anesthesia, Vol. 13, No. 2, Philadelphia, WB Saunders, 1994, in progress
7. "Resuscitation and Trauma Anesthesia", Current Opinion in Anaesthesiology, Vol. 7, No. 2, London, Current Science, 1994, in progress
8. "Manual of Trauma Anesthesia" is in final stages of preparation. Tentatively, the book will be translated into French, German and Spanish

V. Conclusions and Speculations

HISTORY OF TRAUMA ANESTHESIA

David J. Wilkinson, MBBS, FRCAnaes

I. Concept

II. Prehistory

III. Early Civilizations

- A. Mesopotamian**
- B. Egyptian**
- C. Hebrew**
- D. Hindu**
- E. Chinese**

IV. Greek and Roman

- A. Classic**
- B. Greco-Roman**

V. Dark Ages

- A. Western World**
- B. Arabic World**

VI. New Universities

VII. The Renaissance

VIII. 17th Century

IX. 18th Century

- A. Resuscitation**
- B. Physiology**
- C. Wound Care**
- D. Supportive Care**

X. 19th Century

- A. Before Anesthesia**
 - 1. Surgery**
 - 2. Resuscitation**
 - 3. Supportive Care**
- B. Anesthesia**
- C. Asepsis**
- D. X-Rays**

XI. Modern Era

- A. Transport of Casualties**
- B. World War One**
- C. Between the Wars**
- D. World War Two**
- E. Malaya**
- F. Korea**
- G. Vietnam**
- H. The Falklands**
- I. The Gulf**

J. Other Conflicts

XII. Conclusions

ORGANIZATION AND ADMINISTRATION OF TRAUMA ANESTHESIA PROGRAMS

Kenneth J. Abrams, M.D.

I. Introduction

II. Historical Perspectives

- A. Accidental Death and Disability**
- B. Emergency Medical Service Systems Act**
- C. Optimal Resources for the Care of the Seriously Injured**
- D. ITACCS**
 - 1. ASTA**
 - 2. Other ITACCS National Chapters**

III. Impact on Anesthesia Care

- A. Epidemiology**

IV. Organization of Trauma Care

- A. Trauma Systems**
 - 1. The Orange County Experience**
 - 2. National Plans**
 - a. Trauma Care Systems Planning and Development Act**
 - b. Model Trauma Care System Plan**
- B. Trauma Centers**
 - 1. Classification Scheme**
 - 2. Facilities**

3. Trauma Service

V. Trauma Anesthesia Service

A. Personnel

B. Table of Organization

C. Responsibilities and Qualifications

1. Trauma Anesthesia Director

2. Trauma Anesthesia Providers

VI. Roles for Trauma Anesthesia Personnel

VII. Educational Goals

VIII. Potential Conflicts

IX. Continued Quality improvement

X. Summary

**IMPACT OF DRUGS AND ALCOHOL ON MORBIDITY, MORTALITY AND
ANESTHETIC CARE OF THE TRAUMATIZED PATIENT**

Michael J.A. Parr, M.B.B.S., M.R.C.P., FRCAnes

I. Aims of Lecture

- A. Identify Extent of Drug Abuse in Trauma Patients**
- B. Implications of Acute Intoxication, Prolonged Abuse, and Acute Withdrawal to the Trauma Anesthesia/Critical Care Specialist (TA/CCS).**

II. Extent of Problem

- A. Alcohol Implicated Consistently in More Than 50% of Trauma Deaths.**
- B. Growing Evidence that other Illicit Drugs Play a Major Role**
 - 1. Recent Study: at 201 Injured Drivers over a 5 Month Period Admitted to a Level 1 Trauma Center.**
 - a. 37% Positive Blood Alcohol Concentrations (BAC)**
 - b. 40% Were Positive for Other Drugs**
 - c. 57% of the Drivers using Alcohol also had other Drugs Detected**
 - d. Drug Problem on the Highways may be More Significant than Previously Thought.**
 - 2. Another Study: at 169 Trauma Cases Over a 9 Month**

Period

- a. 75% Tested Positive for Drugs; Cocaine 54%, Cannabinoids 37%, Alcohol 35%, Benzodiazepines 10%, Opioids 10%, Barbiturates 7%, Amphetamines 5%.
 - b. Violent Crime Associated with a Positive Drug Screen in 80% of Cases.
3. Baltimore Shock Trauma Center
- a. Substance Dependence Found in 69%.
 - b. A High Proportion of These Dependent Patients had Negative Drug Screens on Admission.

III. Alcohol

- A. Most Common Intoxicant Found in Trauma Victims
 - 1. Risk of Accidents Increases with Increasing Blood Alcohol Concentration.
 - 2. In 1990, 22,083 People Died (75% Male, 62% Aged 16-44 Years) in Alcohol-Related or Alcohol Intoxication-Related MVA's in the USA.
- B. Recognition of the Presence of Alcohol is Usually Relatively Easy.
 - 1. Smell
 - 2. Increased Osmolality
 - 3. Ready Availability of Lab Measurement of BAC
- C. In the Trauma Patient Differentiating the Effects of Intoxication from the Effects of Trauma can be Extremely

Difficult.

1. Management should be Aimed at Excluding all Surgically Correctable Causes Before Signs are Attributed to the Presence of Alcohol and Drugs.

D. Acute Alcohol Intoxication - Many effects that are Important to the TA/CCS, Including:

1. Airway Compromise
2. Hypoventilation
3. Cardiovascular Depression
4. Arrhythmias
5. Hypothermia
6. Coagulation Abnormalities
7. Metabolic Abnormalities
8. Neurological Sequelae
9. The Effects of Alcohol on Anesthetic Requirements

E. Effects of Chronic Alcohol Abuse Including

1. Tolerance
2. Multiorgan Involvement Including
 - a. Cardiomyopathy
 - b. Hepatic Dysfunction and
 - c. Blood and Coagulation Abnormalities (Which May Have Serious Consequences in the Trauma Patient)
 - d. Alcohol Withdrawal Syndrome
 - i. Ranges from Mild to Life-Threatening
 - ii. May Develop in a Matter of Hours

Following Abstinence in the Chronic
Alcoholic

- iii. The TA/CCS Needs to be Aware of the Signs
and Management of Acute Alcohol
Withdrawal

IV. Other Drugs

- A. 1. Estimated >250,000 Cocaine Addicts in the USA
2. Association of Illicit Dealing and Acute
Intoxication with Trauma
3. Cocaine has Superseded Heroin as the Drug of
Greatest Concern for the TA/CCS
- B. Cardiovascular and Neurological Effects of Cocaine
1. Result in Myocardial Ischemia
2. Infarction
3. Cerebrovascular Accidents are a Cause of
Perioperative Morbidity and Mortality
- C. 1. Knowledge of the Signs of Cocaine Intoxication and
Appropriate Management of Acute Cocaine Toxicity is
Essential if the TA/CCS is Going to Provide Optimal
Care for Such Patients
2. Effects, Complications and the Management of Acute
Toxicity and Withdrawal of Narcotics are subjects
that the TA/CCS needs to Be familiar with and will
be discussed in detail.
- D. Other Drugs Commonly Abused by Trauma Patients include

1. Amphetamines
2. Barbiturates
3. Benzodiazepines
4. Phencyclidine (PCP)
5. Volatile Agents

V. Suggested General Management Guidelines

- A. Protect Yourself From Physical Injury and Infection
- B. Anticipate and Protect the Patient from the Effects of Acute Drug Intoxication. Requires:
 1. Carefully monitoring the Patient During the Perioperative Period and Psychological
 2. Physical Assessment. Further Monitoring is Likely to Include:
 - a. Temperature
 - b. ECG
 - c. BP
 - d. Biochemistry
 - e. Blood Gases
- C. Keep an Open Mind and Assume Nothing Until it has been Disproved: Exclude Physical or Metabolic Correctable Causes for Abnormalities Before Putting the Blame on Drug Intoxication.
- D. Anticipate the Complications of Chronic Drug Usage and Take Appropriate Action
 1. Anticipate Withdrawal Syndromes

- 2. Start Appropriate Prophylactic Treatment
- 3. Avoid the Use of Antagonist Drugs
- E. Titrate Anesthetic, Sedative and Analgesic Drugs
- F. Use Direct Vasopressors
- G. Use Drugs with Short Halflives
- H. Anticipate Abnormal Postoperative Drug Requirements
- I. Arrange for Access to Detoxification and Support Services. Attempts at Pharmacological Detoxification are Unlikely to be Successful without Simultaneously Addressing the Psycho-Social Issues.

VI. Summary

- A. Implications of Drug Intoxication for the Trauma Anesthesiologist are Important
- B. Likely to Remain Common Given Current Trends. There Remains Remarkably Little in Terms of Research Material
- C. We as Anesthesiologists have a Responsibility Not Only to Provide Optimal Care for Our Patients but also to Research and Educate to Prevent these Unnecessary Complications.

LEGAL ISSUES IN TRAUMA ANESTHESIA

William H.L. Dornette, M.D., J.D.

I. Introduction to the Law

A. Sources of Laws

- 1. Good Samaritan Statutes**
- 2. Emergency Medical Services Acts**
- 3. Emergency Medical Treatment and Active Labor Act**

B. Contracts for Health Care Delivery

C. Creating the Health Care Provider-Patient Contract

- 1. Emergency Exceptions to Express and Implied Consent**
- 2. Duties of Health Care Provider**
- 3. Duties of Patients**

D. Concept of Professional Negligence

- 1. The Standard of Care**
- 2. Consequences of Violation of a Statute**

E. Informed Consent Doctrine

- 1. Risk/Benefit Ratio**
- 2. Standards of Disclosure**

II. Emergency Care-Related Common Law of Recent Origin

A. Loss of a Chance

B. Misdiagnosis: Failure to Perform Complete Examination

C. Application of Acts and Statutes

III. Conclusion

CONTINUOUS QUALITY IMPROVEMENT FOR TRAUMA ANESTHESIA

Brian G. McAlary, M.D.

I. Introduction

A. Definition

B. History

C. Current Status

- 1. National Practitioner Data Bank**
- 2. OBRA**
- 3. JCAHO: 10 Step Plan**

II. Objectives of QA

A. Patient Outcome: Modification/Improvement

B. Participation by All Department Members

C. Ease of Data Collection

D. Separation of Reporting and Administrative Action

E. "Advocate vs Adversary"

III. Sources of Data

A. Indicator Specific Screening

B. Criteria/Thresholds

C. Hospital Wide Occurrence Screening

D. Incident Reports

E. Blood Utilization Reports

IV. Duties of QA Coordinator

A. Pivotal Role

- 1. Job description**
- 2. Central data collection**
- 3. Liaison: Patient Safety and/or Quality Care Issues**

B. Ongoing Additional Duties

1. Equipment/Supply Issues: Preventive Maintenance
2. Log of equipment servicing
3. Drug inventory: "Look Alike" packaging
4. Narcotic tracking

VI. Overview of QA Elements/Process

- A. Composition of QA Committee
- B. Flow Sheets
- C. Anonymity
- D. Committee Consensus/Joint Decision Making

VII. Implementation of Recommendations

- A. No Censuring
- B. Gain Department Approval of Recommendations
- C. Content of Letters
- D. Present Opportunity for Response
- E. Follow Up
- F. Initial Occurrence
- G. Multiple Occurrence
 1. When and how to notify administration
 2. Personal counseling

VIII. QA Role in Education

- A. Training/Orientation
- B. Focused Inservices: Problem Based
- C. Trending of Apparent Education Deficiencies

IX. Policies and Procedures

- A. Constant Revision**
- B. How to Satisfy External Licensing Agencies**
- C. P & P Serves as "Predefined Yardstick"**

X. Followup Phase

- A. Outcome Analysis**
- B. Problem Solved: Delete Indicator**
- C. Problem Remains**
 - 1. Repeat education effort**
 - 2. Alternative solution**
 - 3. Notify Director**

PLENARY SESSION 2:
Pharmacology in Trauma Anesthesia

Moderator: Leo H. D. J. Booij, MD, PhD, FRCAnaes

Muscle Relaxants

Leo H. D. J. Booij, MD, PhD, FRCAnaes

Intravenous Agents

Levon M. Capan, MD

Inhalation Agents

Levon M. Capan, MD

Discussion

MUSCLE RELAXANTS

Leo HDJ Booij, M.D., Ph.D.

I. Introduction

- A. Anatomy of Neuromuscular Junction**
- B. Physiology of Neuromuscular Transmission**

II. Pharmacology of Neuromuscular Transmission

- A. Mechanism of Neuromuscular Transmission**
 - 1. Depolarizers**
 - 2. Non-Depolarizers**

III. Factors Affecting Neuromuscular Transmission

- A. Interfering Diseases**
 - 1. Hepatic Diseases**
 - 2. Renal Diseases**
 - 3. Neuromuscular Diseases**
- B. Interfering Drugs**
 - 1. Antibiotics**
 - 2. Anesthetics**
 - 3. Miscellaneous**
- C. Pharmacokinetic Changes**
 - 1. Shock, Protein Binding, and Volume of Distribution**
 - 2. Redistribution**
 - 3. Metabolic and Elimination**

IV. Choice of Relaxant in Trauma Anesthesia and Critical Care

A. Pharmacologic Properties

1. Onset of Action
2. Duration of Action
3. Offset of Action

B. Adverse Effects

1. Cardiovascular Effects
2. Histamine Release

C. Properties of Some New Non-Depolarizing Relaxants

1. Doxacurium
2. Mivacurium
3. Pipecuronium
4. Rocuronium

INTRAVENOUS ANESTHETICS AND OPIOIDS IN TRAUMA MANAGEMENT

Levon M. Capan, M.D.

I. Properties of Available Intravenous and Opioid Agents

- A. Thiopental**
- B. Methohexital**
- C. Midazolam**
- D. Etomidate**
- E. Propofol**
- F. Ketamine**
- G. Fentanyl**
- H. Alfentanil**
- I. Sufentanil**

II. Use of Intravenous Agents in Various Trauma Settings

- A. Hypovolemia**
- B. Head, Eye and Sealed Major Vessel Injury**
- C. Airway Compromise**
- D. Cardiac Injuries**
- E. Sedation, Brain Protection and Alcohol Withdrawal**

INHALATION ANESTHETIS IN TRAUMA MANAGEMENT

Levon M. Capan, M.D.

- I. Desirable Properties of "Ideal" Inhalational Agent in Trauma Anesthesia**
 - A. Minimal Hemodynamic Effect in Hypovolemia**
 - B. Minimal Effects on Intracranial and Intraocular Pressure Dynamics**
 - C. Minimal Adverse Effect During Prolonged Use**

- II. Comparison of N₂O, Halothane, Enflurane, Isoflurane, Desflurane and Sevoflurane**
 - A. Cardiovascular Effects**
 - B. Respiratory Effects**
 - C. Metabolism**
 - D. Other Effects**

- III. Use of Inhalational Agents in Various Trauma Settings**
 - A. Hypovolemia**
 - B. Head, Open Eye and Vascular Injuries**
 - C. Cardiac Injuries and Diseases**
 - D. Prolonged Surgery**
 - E. In the Field and Postoperatively**

PLENARY SESSION 3:

Forum on Pain Management for Trauma

Moderator: David P. Tarantino, MD

Pathophysiologic Responses to Pain After Injury

Leo H. D. J. Booij, MD, PhD, FRCAnaes

Systemically Administered Agents

T. James Gallagher, MD, FCCP, FCCM

Invasive Pain Control Techniques

David P. Tarantino, MD

Panel Discussion and Case Presentations

David P. Tarantino, MD

PATHOPHYSIOLOGIC RESPONSES TO PAIN AFTER INJURY

Leo HDJ Booij, M.D., Ph.D.

I. Introduction

- A. Anatomy of Major Pain Pathways**
- B. Physiology and Neuropharmacology of Acute Pain**

II. Why Treat Pain?

- A. Effect on Respiration**
- B. Effect on Circulation**
- C. Stress Responses to Pain**

III. Conclusions

PAIN CONTROL AND SEDATION IN THE CRITICALLY ILL

T. James Gallagher, M.D.

I. Introduction

- A. Desirable Goals in the care of the Critically Ill include the reduction of Anxiety, Agitation and Pain**
- B. Pain is Frequent Accompaniment in the Critically Ill, particularly following Invasive Procedures or Surgery**
- C. Sedation may be Appropriate in the patient undergoing an Invasive Procedure or requiring Paralysis during Mechanical Ventilatory Support.**
- D. Under certain circumstances it may be desirable to Induce Sedation and/or Paralysis to Reduce Metabolic Oxygen Requirements**

II. Narcotics and Non-Narcotics

- A. The vast majority of Pain Control in the Critically Ill is Achieved by Narcotic administration**
- B. There are several different drugs available**
- C. In a Minority of instances, Non-Narcotics may be the choice including:**
 - 1. Patient with Neurologic Injury in whom Physical and Neurologic Examination must be carried out routinely**
 - 2. Patient with Chronic CO₂ Retention**
- D. In our practice, Morphine remains a Mainstay of therapy**

1. Agent has superior analgesic and sedative properties
 2. a. When a Shorter Duration of Action may be desirable, Fentanyl will often be the Substitute Drug of Choice
 - b. Excellent Analgesic Properties
- E.
1. Both agents can contribute to Respiratory Distress with a Rightward Shift to the CO₂ Response Curve
 2. More likely to occur with Cumulative Doses
 3. Alone, neither Drug has significant cardiovascular depressant effects.
 4. Morphine may be a somewhat better vasodilator, particularly if dosages are such that Histamine Release occurs
 5. Truly Depressant Cardiovascular Effects of the agents are seen when they are administered during Anesthesia in conjunction with Nitrous Oxide
- F.
1. Ketorolac is Non-Steroidal Anti-Inflammatory Drug which has enjoyed increased popularity of late
 2. Approved for use in 1991
 3. Contains Anti-Inflammatory and Antipyretic Effects
 4. Major benefit is its superior analgesic property to other Non-Narcotics coupled with absent Respiratory Depression
 5. Can Increase Bleeding Time, which occurs in the presence of normal platelet counts, in Peak PT and

PTT Times

III. New Routes of Administration for Analgesic Agents

- A. Transdermal, Transnasal, Alipholized vehicles and other new approaches have not met with much acceptance in the Critical Care Environment**
- B. Today, it seems primitive to deliver intramuscular injections of analgesics**
- C. 1. Intravenous Route remains Practical and Acceptable**
2. We currently use less and less Intermittent Intravenous Administration
- D. 1. Instead, Continuous Infusions have become popular utilizing either Morphine or Fentanyl**
2. Ordinarily, Morphine may be administered at rates of 1 to 6 mg/hr or, Fentanyl infused at 1 m/kg/hr
3. Particularly useful in patients who require ongoing Sedation and Pain Relief and who are not candidates for either a PCA Pump or Epidural Administration

IV. Patient Controlled Analgesic (PCA)

- A. Improved Postoperative Patient Care**
- B. Clinician is able to Maintain Continuous Drug Levels**
- C. Likelihood of Overdose is Minimized**
- D. Potential Drawback is "helpful" family or friends Who may administer the drug even if the patient doesn't really require further dosing**

- E. Works less well in Children and those Confused or otherwise unable to handle the chore of pushing the appropriate button
- F. Morphine still seems the most popular agent for this approach

V. Epidural Narcotics

- A. Excellent pain relief, particularly following Abdominal or Intrathoracic surgical procedures
- B. Epidural Infusions help relieve pain following Chest Trauma or other injuries including Fractured Ribs
- C. Two most popular agents are Morphine and Fentanyl
 - 1. Morphine, because of its slower uptake, may be superior to Fentanyl's effect in providing pain relief at some distance from the infusion site.
 - 2. Fentanyl's effect may not be due to intraspinal migration, but in fact Simply Parenteral Uptake of the Agent
 - 3. Therefore, epidural relief of thoracic pain, either lumbar or thoracic morphine or a thoracic fentanyl are the appropriate choices
- D.
 - 1. With the lumbar approach, Higher Doses of Morphine will be required and to supply abdominal pain relief
 - 2. Morphine can be usually administered in 2 to 6 mg dosages, intermittently every 6-24 Hours

3. It can also be administered as a Continuous Infusion at 0.5 mg/hr
4. Fentanyl, When used via the Epidural Approach, is administered in the Continuous Infusion

VI. Respiratory Depression

- A. Fentanyl above 1 u/kg/hr the incidence of Respiratory Depression and other Complications will Increase
- B.
 1. In Order to prevent higher dosages but still supply adequate pain relief, Bupivacaine in 1/16% Concentration can be added to the infusion
 2. Will affect sensory fibers but will not impact upon motor function
- C.
 1. Some advocate a continuous infusion of a Narcotic Antagonist such as Nalaxone in combination with the narcotic administration
 2. Extremely difficult to maintain adequate pain relief while at the same time preventing all aspects of Respiratory Depression
 3. Overall Incidence of Respiratory Depression remains about 1%, therefore, the Nalaxone administration seems ill advised
 4. Few patients in the Intensive Care Unit environment complain of pruritus or urinary retention

VII. Intrapleural Analgesic

- A. Utilized to relieve thoracic pain following Thoracotomy and/or Multiple Rib Fractures
- B.
 - 1. Unclear how the drugs work
 - 2. May include Diffusion through the Parietal Pleura, to block Intercostal Nerves, or Nerve Roots and Sympathetic Ganglia
- C.
 - 1. Some advocate Two Catheters to insure that coverage is adequate When positions are changed
 - 2. In patients with Chronic Adhesions, this technique may not be very satisfactory
 - 3. Our experience is that we have had Limited Success
- D. The Drug may also be Instilled through a Chest Tube already in place

VIII. Anxiolysis

- A. Adequate relief of Anxiety may reduce the overall psychological impact of the Intensive Care Unit stay, reduce Analgesic needs, and decrease Metabolic Oxygen Requirements
- B. Most agents used in the Critical Care environment are either Benzodiazepines or agents such as Propofol
- C.
 - 1. The most popular Benzodiazepines are midazolam and lorazepam
 - 2. All given primarily by Continuous Infusion
 - 3. On the Short Term usage they may be given on the Intermittent Intravenous Basis

4.
 - a. These agents have minimal impact upon cardiovascular function
 - b. Some studies have indicated some depression of Cardiac Index with Midazolam
 - c. Vasodilation may occur with some drop in Blood Pressure during the initial administration of Propofol
 - d. Studies to date have indicated little impact on cardiac function with Lorazepam given by intermittent administration
 - e. Respiratory Depression can occur with any of these agents particularly if in Combination with a Narcotic
 - f. Effects May be exaggerated in the Elderly who generally require Decreasing Dosages
 - g. When administered in appropriate dosages these agents can reduce Metabolic Oxygen Demands

VIII. Summary

SPECIAL PROBLEMS IN ACUTE PAIN MANAGEMENT OF THE TRAUMA PATIENT

David Tarantino, M.D.

I. Introduction

- A. Pain Management is an Increasingly Important Aspect of Overall Care of Trauma Patients**
- B. Pain Management Regimens must take into account Multiple Mechanisms and Sites of Injury**

II. Compartment Syndrome

- A. May occur in any of the Fascial Compartments of the Limbs**
- B. Will Epidural Analgesia mask development of Compartment Syndrome**
 - 1. Strecker et al: Epidural Bupivacaine Masks Compartment Syndrome?**
 - 2. Montgomery et al: Compartment Syndrome Readily Diagnosed in Patients**
- C. Recommendations**

III. Dressing Changes

- A. Morphine or Meperidine May Not be Adequate**
- B. Epidural; Pros and Cons**
- C. Ketamine/Midazolam: Pros and Cons**
- D. Alfentanil PCA: MIEMSS Experience**

IV. Substance Abuse

- A. Use of PCA: Controversial
- B. Choices of Opioids
- C. Use of Methadone
 - 1. Conversion from IV Morphine
 - 2. Weaning

V. Conclusions

PLENARY SESSION 4:

Forum on Trauma Anesthesia Research – Historical Overview and Sources of Funding

This session will present a view from several investigators in the area of trauma. Specifically to be reviewed are the motivation and forces supporting the previous consensus conferences on trauma and the recent role of the Centers for Disease Control. Sources of funding solicited from the public, federal authority, and military sources, will also be reviewed, as well as the type of research funded and a compilation of data on outcome.

5:30-7:10 P.M. Moderator: *Enrico M. Camporesi, MD*
Panelists: *Dean E. Calcagni, MD*
Ronald G. Pearl, MD, PhD
Timothy G. Buchman, MD, PhD,
FACS, FCCM
Bruce F. Cullen, MD

7:10 P.M. Discussion
Enrico M. Camporesi, MD

US ARMY COMBAT CASUALTY CARE RESEARCH PROGRAM

Lt. Col. Dean E. Calcagni, M.D.

- I. The US Army Medical Research and Development Command**
- II. Similarities and Differences of Civilian Versus Military Trauma Care Needs**
- III. University/Medical Center Funding of Selected Research by the Combat Casualty Care Research Program**
 - A. The Starting Point - The "Broad Agency Announcement"**
 - B. Procedures**
 - C. Timetables**
 - D. Prognosis**
- IV. Areas of Research in the Combat Casualty Care Research Program. ("*" currently the Highest Priority)**
 - A. Airway and Ventilation**
 - 1. Physiologic Monitor (BAS/Evac)**
 - 2. Suction Device**
 - 3. Oxygen Concentrator/Generator/Supply (BAS/Evac)**
 - 4. Airway Management Methods**
 - 5. Ventilatory Support Methods**
 - *B. Blood Loss/Resuscitation**
 - * 1. Intraosseous Infusion Device**
 - * 2. Fluid Infusion/Warming Device (Chem)**

- * 3. Plasma Substitute (Hemorrhagic Shock)
- * 4. Blood Substitute
- * 5. Thawed Blood Processing Device
- * 6. Blood Preservatives
- * 7. Platelet Preservative/Substitute
- * 8. Local Hemostatic Agents
- * 9. Oxygen Delivery and Perfusion
- C. Secondary Damage After Hemorrhage
 - * 1. Cell Death/Organ Failure
 - * 2. Ischemia/Reperfusion Injury
 - * 3. Secondary Brain/Spinal Cord Injury
 - 4. Immunosuppression and Sepsis
 - * 5. Reduce Demand for Substrates
 - 6. Systemic Antibiotic/Antimicrobials
 - 7. Bacterial Translocation
- D. Systems for Casualty Management
 - 1. Expert System for Trauma Management
 - 2. Smart Life Support Systems
- E. Musculoskeletal Injury
 - 1. Antiinflammatory and Analgesic Drugs
- F. Soft Tissue Injuries
 - * 1. Wound/Abrasion Dressings
 - 2. Topical Antibiotic/Antimicrobial
 - 3. Skin Repair Factors
- G. Combat Stress Casualties
 - * 1. Behavioral Aids for Combat Stress Casualty

- *
 - 2. Diagnostic Software for Combat Stress Casualty
 - 3. Drugs for Treatment of Combat Stress Casualty
- H. Anesthetic and Delivery Systems
 - *
 - 1. Field Anesthesia Machine
 - 2. Intravenous Anesthetics
- I. Far Forward Surgical Materiel Set
 - 1. Mechanical Ventilator
 - 2. Suction Device
 - 3. Fluid Infusion/Warming Device (Rapid)
 - 4. Sterilization System for Surg Instruments
 - 5. Physiologic Monitor (Fwd Surg Team)
 - 6. Portable Diagnostic Equipment
 - 7. Oxygen Concentrator/Generator/Supply (FAST)
 - 8. Surgical Wound Dressings
 - 9. Field Medical Material Support
- J. Battle and Non-Battle Injury
 - 1. Surgical Management of Ballistic Injury
 - 2. Blast Injuries
 - 3. Neuronal Regeneration
 - 4. Bone Repair/Regeneration
 - 5. Burn Injuries
 - 6. Crush injury
 - 7. Plasma Substitute (Burn Shock)
 - 8. Vascular Healing
 - 9. Chemical Burns (Excludes CW Injuries)

V. Products Under Development in the Combat Casualty Care Research Program

A. Diagnostic and Therapeutic Field Devices

1. X-ray Systems, Dental, Miniature (XRSDM)
2. Medical Filmless Imaging System
3. CT Scanner, (Field)
4. X-Ray System, Lightweight, Medium (XRSLW)
5. Field Anesthesia Machine (FAM)
6. Intravenous Access Device
7. Combat Emergency Medical Expert Systems
8. Filmless Dental Imager (XRDSM) (P31)
9. Monitor, Vital Signs
10. Lightweight X-Ray Film Developing Kit
11. Self Contained Ventilator (6/2/92)
12. Life Detector
13. Lightweight Hi-Cap X-Ray system
14. Portable X-Ray Table
15. Portable Multi-Mode X-Ray Imaging System

B. Medical Supply Production and Hospital Support Field Devices

1. Resuscitation Fluids Products Systems (REFLUPS)
2. Field Medical Oxygen Generator and Distribution System (FMOGDS)
3. Molecular Sieve Oxygen Generating System
4. Liquid Oxygen Generator, Production and Distribution System (LOX)

5. Medical Supply Envelope
6. Field Triage Light
7. Truck, 2-Wheeled, Gas Cylinder (MC)
8. Chemical Protective Patient Wrap
9. Thermometer, Impact Resistant, Wide Range
Physiologic
10. Far Forward Suction Apparatus

C. Other Medical Devices for the Field

1. Medical Systems Support Programs
2. External Rescue Hoist, UH-60
3. Comp Assist Post-Mort ID System (CAPMI)
4. Comp Assist Post-Mort ID System (PSI)
5. Air Ambulance
6. Armored Ambulance M113 (MC)
7. Armored Aid Station

PUBLICATION OF TRAUMA ANESTHESIA RESEARCH

Ronald G. Pearl, M.D., Ph.D.

I. Overview of Publication of Trauma Anesthesia Research

II. What Makes a Study Publishable?

- A. The Topic**
 - 1. Rationale for the Study**
 - 2. Originality**
 - 3. Creativity**
- B. Methods**
- C. Results**
- D. Statistical Analysis**
- E. Presentation of the Data**
- F. Discussion**
- C. Common Mistakes to Avoid**

III. Specific Issues in Trauma Anesthesia

- A. Prospective Randomized Studies**
- B. Case Series**
- C. Case Reports**
 - 1. Specific Issues**
 - 2. New Approaches**
- D. Laboratory Research**

FORUM ON TRAUMA ANESTHETICS RESEARCH

Timothy G. Buchman, M.D., Ph.D.

I. Stress Gene Expression and Multiple Organ Dysfunction Syndrome

A. Program of Stress Gene Expression

- 1. Acute Phase**
- 2. Heat Shock**
- 3. Others**

B. Mediators of Stress Gene Expression In Vivo

- 1. LPS, TNF, IL-1, IL-6 (Acute Phase)**
- 2. Superoxide Heat Shock**

C. Interactions Between Programs of Stress Gene Expression

- 1. Hepatic Parenchymal Cells**
- 2. Endothelial Cells**

D. Clinical Issues

II. Strategies for Obtaining Research Support

A. Overview of Support Sources

- 1. Intramural**
- 2. Extramural**
 - a. Professional Societies (e.g., AUA)**
 - b. Not-for-Profit Organizations (e.g., AHA)**
 - c. Federal Programs**
 - i. VA**
 - ii. NIH**
 - iii. NSF**

B. The National Institutes of Health

- 1. Overview**
- 2. Interested Institutes**
- 3. Investigator-Initiated Research**
 - a. R Series Awards (R01, R29, R55)**
 - b. K Series Awards (K08, K04)**
- 4. The Initial Review Group:**
 - a. Surgery, Anesthesiology, Trauma (SAT)**
- 5. Recent NIH Support in Trauma/Anesthesiology**

C. Proven Strategies for Success in Grant Application

- 1. A Personal Perspective**

FORUM ON TRAUMA ANESTHESIA RESEARCH

Bruce F. Cullen, M.D.

I. Topics and Areas of Interest

A. Laboratory

- 1. Leukocyte Adherence and Reperfusion Injury**
- 2. Muscle Relaxants and Burn Injury**
- 3. Management of Head Injury**
- 4. Opioid Transport through Neural Membranes**
- 5. Pulmonary Effects of Neurologic Injury**

B. Clinical

- 1. Electrolyte Changes with Multiple Transfusion**
- 2. Effect of Alcohol on Anesthetic Requirements**
- 3. Effect of Anesthetic Drugs (Ketamine, Alfentanil, Propofol) on Cerebral Perfusion and Intracranial Pressure**
- 4. Hyperglycemia and Neurologic Outcome Following Head Trauma**
- 5. Efficacy of Transcranial Doppler in Management of Head Injury**
- 6. Muscle Relaxants and Antibiotic Drug Interactions**
- 7. Alfentanil PCA Analgesia for Burn Wound Debridement**
- 8. Transdermal Fentanyl for Background Burn Wound Pain Management**
- 9. Sciatic Nerve Block Anesthesia for Lower Extremity Fractures.**

**10. Intraneural Nerve Block for Pain Management
Following Leg Amputations**

II. Personnel Needs

III. Source of Funding

IV. Problem Solving

SIMULTANEOUS SESSION 1.

Special Techniques and Equipment for Trauma Anesthesia

This session will begin with didactic presentations of special techniques for trauma anesthesia in the field, desirable safety features of anesthesia equipment, features of field anesthesia machines, and other portable anesthesia apparatus such as ventilators. The second half will involve practical "hands-on" demonstrations of available anesthesia equipment. In addition to the anesthesia equipment experts, representatives from each manufacturer will be available to address technical issues.

Moderator: William Clayton Petty, MD

Panelists: Brian F. Condon, MD

Leland H. Hanowell, MD

Charles P. Kingsley, MD

*Colin A. B. McLaren, MB ChB,
FRCAnaes*

John Restall, MB, BS, FRCAnaes

FIELD ANESTHESIA MACHINES: PAST AND PRESENT

W. Clayton Petty, M.D.

I. History

- A. Surgeon Amputating a Leg**

II. Civil War

- A. Ether for Amputation**
- B. Portable Anesthesia Machine of Clover**

III. World War I

- A. Flagg Can**
- B. Heidbrink Model-T**

IV. World War II and Korean War

- A. Heidbrink Machine 775**

V. Vietnam War

- A. Cyclopropane**
- B. Model 885**
- C. Fluotec in Vietnam**
- D. Model 885A**
- E. Vaporizer Major Problem**
 - 1. Filling Port Universal**
 - 2. Human Error**

VI. Desert Storm

- A. We Have a Problem**
- B. Different Perspective**
- C. Two Major Deterents of Machine: Teaching and Standards**
- D. Standards**
- E. Acceptance**

VII. Summary

PERIOPERATIVE MANAGEMENT OF THORACOABDOMINAL TRAUMA

Leland H. Hanowell, M.D.

I. Introduction: The First Twenty-Four Hours

- A. Introduction/Epidemiology**
- B. Initial Evaluation**
- C. Treatment of Gastric Dilation**
- D. Tube Thoracostomy for Thoracic Trauma**
- E. Trauma Operating Room Preparations**
- F. Hypothermia**
- G. Preoperative Assessment of the Airway**

II. Anesthesia for Thoracoabdominal Trauma

- A. Induction of Anesthesia for Thoracoabdominal Trauma**
- B. Neuromuscular Relaxation**
- C. Awareness During Anesthesia for Thoracoabdominal Surgery**
- D. Inhaled Versus Intravenous Anesthesia**
- E. Management of Open Chest Resuscitation**
- F. Mechanical Ventilation of the Non-Compliant Lung**
- G. Perioperative Hemodynamic Instability/Monitoring**
- H. Placement of Double-Lumen Endotracheal Tubes**
- I. One Lung Anesthesia**
- J. Hypoxic Pulmonary Vasoconstriction**

III. Fluid/Blood Administration for Thoracoabdominal Trauma

- A. Colloid or Crystalloid**

- B. Rapid Infusion of Blood Products
- C. Intraoperative Autotransfusion

IV. Perioperative Complications

- A. Coagulation Abnormalities
- B. Disseminated Intravascular Coagulation
- C. Adult Respiratory Distress Syndrome

V. Thoracic Trauma

- A. Bronchial Tears, Tracheal Disruptions, Bronchopleural
Fistulae
- B. Air Embolism Complicating Chest Trauma
- C. Chest Wall Injury and Flail Chest
- D. Airway Obstruction by Foreign Body

VI. Cervicothoracic Trauma

- A. Epidemiology, Etiologies, and Diagnosis
- B. Anesthetic Management for Thoracic Aortic Trauma
- C. Coordination of Anesthesia and Surgery During Aortic
Repair
- D. Spinal Cord Injury Associated with Thoracic Aortic Repair
- E. Left Heart Bypass for Repair of Thoracic Aortic Trauma

VIII. Cardiac Injuries

- A. Cardiac Tamponade
- B. Cardiac Contusion

C. Myocardial Injuries

IX. Transesophageal Echocardiography

X. Abdominal Injuries

- A. Diaphragmatic Rupture**
- B. Injury to the Spleen**
- C. Liver Laceration**
- D. Intestinal Trauma**
- E. Pancreatic and Retroperitoneal Trauma**

XI. Other Torso Trauma

XII. Early Postoperative Care

- A. Diaphragmatic Dysfunction**
- B. Newer Modes of Mechanical Ventilation**
- C. Incentive Spirometer/Postoperative Bronchodilators**

XIII. Pain Management for Thoracoabdominal Trauma

- A. Epidural Analgesia**
- B. Patient Controlled Analgesia**
- C. Intrapleural and Intercostal Blocks**

XIV. Conclusion

ANESTHESIA EQUIPMENT SESSION

Charles P. Kingsley, M.D.

I. Historical Perspective

II. Drawover Equipment

- A. Schimmelbusch Mask**
- B. Flagg Can**
- C. EMO Inhaler**
- D. OMV Vaporizer**
- E. PAC Vaporizer**

III. Effects of:

- A. Temperature**
- B. Minute Ventilation**
- C. Supplemental Oxygen**

IV. Oxygen Concentration Equipment

V. Equipment for Use with Concentrators

VI. Ventilators for Austere Conditions

- A. Mechanical**
- B. Fluidic**
- C. Electronic**

VAPORIZER COMPARISON

DRAWOVER VAPORIZERS

Lightweight, portable, durable

Oxygen advisable but optional

May be used with an Oxygen Concentrator

Open Circuit consumes Oxygen and Anesthetic Agent

Ambient Temperature Affects Output at Extremes

Minimum FI02 is 21%

Rapid Changes in Anesthetic Concentrations

Calibrated, Temperature Compensated Vaporizers

Minimal Maintenance Required

PLENUM SYSTEMS

Larger, designed for Fixed Facilities

Mandatory requirements for Oxygen

May use Nitrous Oxide

May use Low Flows to Conserve Oxygen and Agent

Conserves Heat and Humidity

May deliver a Hypoxic Mixture

Circle system blunts Concentration Changes

Vaporizers may/may not be Calibrated and Compensated

Carbon Dioxide absorbent required

DRAWOVER VAPORIZER SPECIFICATIONS

SPECIFICATION	EMO	OMV	PAC
Weight (kg)	5.25 dry 6.5 with H2O	1.4	2.3
Height (cm)	24.0	14.5	19.0
Width (cm)	23.0	13.5	9.5
Diameter (cm)	23.0	11.0	13.0
Temperature Range	13-32 C	20-30 C	18-35 C
Thermal Compensation	Metal Bellows Water Jacket	Glycol Solution	Bimetallic Strip
Resistance	1.25 cm H2O @40 L/min	< 1 cm H2O	1 cm H2O @ 30 L/min
Capacity (ml)	450	50	85
Concentration	2-20% Ether	0-3.5% Multi-agent	0-5% Multi-agent

OXYGEN AND ANALGESIA IN THE FIELD

C.A.B. McLaren, FRCA

I. Introduction

- A. Physiological Requirements for Oxygen**
- B. Oxygen Generation**
- C. Comparison of Various Methods of Generation**
 - 1. Solid State ... Chemical Generation**
 - 2. Cylinders**
 - 3. Liquid Oxygen**
 - 4. Hydrogen Peroxide**
 - 5. Oxygen Concentrator...Molecular Sieve**

II. Oxygen and Anesthetic Equipment in the Field

- A. Problems and Resupply**

III. Analgesia: Historical Review From Alcohol to Anesthesia

- A. Analgesic Drugs**
- B. NSAIDS**
- C. Potency of Drugs Available**
- D. Complications**
- E. Delivery Systems**
- F. Future Developments**

TRAUMA ANESTHESIA IN THE FIELD

John Restall, MB, BCH, FFARCS

I. Equipment and Suitable Techniques

A. Who is Going to Use the Equipment?

- 1. Anesthesiologists**
- 2. Nurses**
- 3. Others**

II. The Responsibilities of the Anesthesiologist in the Field

III. Where is the Equipment likely to be Used?

A. Anywhere

B. Problems:

- 1. Extremes of Temperature**
- 2. Clinical Conditions**
- 3. Other Factors**

IV. The Equipment

- A. Essential Features of an Anesthetic Machine**
- B. Features of Draw-Over Apparatus**
- C. The Tri-Service Anesthetic Apparatus (TSA)**
- D. The OMV-50 and Universal PAC Vaporizers**

V. Anesthetic Drugs - Essential Features

VI. Development of Total Intravenous Techniques (TIVA)

A. Use of Ketamine and Midazolam

B. Experience of the Red Cross with Ketamine

VII. Ventilators:

A. Cape TC-50

B. Porta-Pac

VIII. Basic Monitoring in the Field

IX. Laryngeal Mask Airway

X. Importance of Record Keeping

XI. The Use of Regional Techniques

XII. Postoperative Recovery

XIII. Resupply

XIV. Lessons to be Learned

SIMULTANEOUS SESSION II.

Pediatric Trauma Anesthesia

The pediatric trauma patient presents unique problems. Specific aspects of the management of closed head injury, initial resuscitation, and transport of the injured child will be presented.

Additionally, a "hands-on" mini-session on intraosseous infusion will be presented.

Moderator: Aleksandra Mazurek, MD

Past and Future of Pediatric Trauma: The Role of the Anesthesiologist and Adult Surgeon in the Care of Pediatric Trauma Victims

J. Michael Badgewell, MD

Pain Management in Pediatric Trauma Victims
Armin Rieger, MD

Transport of the Critically Injured Child
Philippe-Gabriel Meyer, MD

Procedures in Pediatric Life Support
Myron Yaster, MD

Questions and Answers

Round Table – Prehospital Care of an Injured Child

Moderator: Aleksandra Mazurek, MD

Panelist: J. Michael Badgewell, MD

Jeffrey M. Berman, MD

Steven C. Hall, MD, FAAP

Philippe-Gabriel Meyer, MD

Linda Jo Rice, MD, MC, USNR

Armin Rieger, MD

Myron Yaster, MD

Intraosseous Infusion Introduction

Jeffrey M. Berman, MD

Intraosseous Infusion Workshop

THE ROLE OF THE ADULT SURGEON AND ANESTHESIOLOGIST
IN THE CARE OF PEDIATRIC TRAUMA VICTIMS

J. Michael Badgwell, M.D.
Texas Tech University Health Sciences Center
The Children's Hospital at University Medical Center
Lubbock, Texas

Although the care of pediatric trauma victims is a continuum that begins with initial treatment at the scene and continues through to the postoperative period in the intensive care unit, the present discussion will concentrate on the presurgical period as the child enters the emergency department or operating room. It is at this point that there is very little difference between the role of surgeons and anesthesiologists in the care of these children; therefore I will refer to both surgeon and anesthesiologist as "physician."

Initial Care

Prevention of Hypothermia:

It is a primary role, for all concerned, to maintain the body temperature of the traumatized child. Hypothermia is very counterproductive to the resuscitation and therefore every effort should be made to keep the child warm. Therefore, in these children, it is essential to take measures early in the course of management to promote the preservation of body heat (heated or reflective blankets for transport, heated intravenous fluids, warm environment, etc.).

Recognition of the Extent of Injury

Hypovolemia:

A very important role of the physician at this stage is the recognition of hypovolemia. The earliest manifestations of shock are delayed capillary refill, mottled skin, and cool extremities. Tachycardia also occurs early in shock and indicates the loss of circulating blood volume. Systolic blood pressure remains relatively constant due to peripheral vasoconstriction and is frequently maintained until there is 30-40% loss of circulating blood volume. By contrast, diastolic blood pressure is a good indicator of filling pressure and decreases gradually in the hypovolemic child. Peripheral pulses may be absent depending on the intensity of vasoconstriction. Absent peripheral pulses and tachycardia in the presence of decreasing diastolic blood pressure should alert the physician that cardiovascular collapse is imminent. Arterial pH is the best indicator of circulatory status. If pH is low in the presence of normal or low carbon dioxide, one should assume the circulating blood volume is inadequate until proven otherwise. Metabolic acidosis secondary to low perfusion state in hypovolemic children is corrected with adequate fluid resuscitation. However, should the pH fall below 7.2 in the child with adequate ventilation, sodium bicarbonate may be added to the fluid replacement (dose = body weight in kg x 0.15 x base deficit given as an IV bolus followed by reassessment of pH)¹.

Increased Intracranial Pressure:

The mortality of children increases dramatically in multiple trauma is associated with closed head injury. Unfortunately, there is little the physician can do for the primary tissue destructive effects of head injury. Injuries secondary to hypoxia, hypotension, edema, increasing intracranial pressure, and increased metabolic demand (e.g. seizures or fever), however, may be attenuated with appropriate care. In hypotensive children with closed head injury, hypotension is usually caused by something other than the head injury (e.g. abdominal injury). Although an infrequent occurrence, infants may become hypotensive from a head injury due to blood loss into either the subgaleal or epidural space. The infant with an open fontanelle and mobile sutures is more tolerant of an expanding intracranial mass. Therefore, a bulging fontanelle in an infant who is not in coma should be treated as a more severe injury.

Neurological evaluation focuses on the presence of increased ICP. Increased ICP is common in children with head injury and occurs most often without a mass lesion. The Glasgow Coma Scale provides a fairly accurate estimate of ICP (Appendix). A child who can "wiggle, open, and answer" (i.e., a child who can wiggle his fingers and toes, open his eyes, and answer simple questions) probably does not have raised ICP. On the other hand, a child with Glasgow Score of 8 or less probably has significantly increased ICP, and the child with a score of 6 or less has increased ICP that

demands immediate and aggressive intervention to prevent uncal herniation. Although children frequently vomit after head injury without increased ICP, persistent vomiting and recurring seizures suggest increase in ICP.

Vascular Access

The initial treatment of hemorrhagic shock is intravascular resuscitation with crystalloid solutions. Therefore, establishing vascular access with large bore cannulae has immediate priority and can be accomplished by either the anesthesiologist or the surgeon. Percutaneous cannulation of internal jugular or subclavian veins is not recommended during initial resuscitation because of the risk of pneumothorax or hemothorax. However, if the physician is proficient with cannulation of these large central veins, he/she is encouraged to do so in life-threatening situation where no other access is available. Furthermore, a central venous pressure is planned. Venous access should be established initially via a percutaneous route if possible. If this route is unsuccessful, a direct cut down at the saphenous, cephalic, or external jugular vein may be performed. Alternatively, a femoral vein may be cannulated using the Seldinger technique. In suspected abdominal or thoracic bleeding, at least one IV site should be in the neck or upper extremity.

Various kits are available or can be assembled from readily available for use in the Seldinger technique. Depending on the

child's size, either a #20 or #22 catheter (Deseret Angiocath, Becton-Dickinson Vascular Access, Sandy, Utah) is first inserted into the vein. In the smaller child, use of a 0.45 mm spring wire guide (Arrow Duoflex, #AW-04018, Reading, PA) may facilitate insertion of #22 (or larger) catheter. In the larger child, the insertion of a #20 catheter will allow a 0.635 mm spring guide wire and then the insertion of a 7 French Catheter (Arrow, Rapid Infusion Catheter Exchange Set, #RC-09700). A 7 French catheter will allow infusion rates of up to 750 ml/min using a mechanical rapid infusion system.

Endotracheal Intubation

Swelling, secretions, and bleeding from trauma and the collapse of soft tissue as the child loses consciousness may cause obstruction of the airway. If obstruction is present, the airway should be opened by the head-tilt/chin-lift or, when neck injury is suspected, by the jaw-thrust maneuver. The airway is opened in combination with gentle suction. Spontaneously breathing children should receive supplemental oxygen either by face mask or nasal cannulae. In general, these children are usually better off if they are allowed to breathe spontaneously. If the child can maintain an airway, he/she should be allowed to do so without added intervention. However, if respiratory compromise persists, positive pressure ventilation using bag and mask and possible endotracheal intubation may be required.

Generally speaking, if a traumatized child will tolerate a plastic artificial oral airway, he/she is obtunded enough to require an endotracheal tube. Similarly, this is true for nasal airways. Furthermore, an artificial nasal airway may produce epistaxis or nasopharyngeal bleeding (especially in the hypothermic and possibly coagulopathic child). Therefore, artificial airways have limited usefulness in the trauma situation.

In the child without suspected head or neck injuries, endotracheal intubation can be accomplished in the routine manner. Special considerations should be taken that the child will have a full stomach; therefore, a rapid sequence induction should be performed.

There are some important anatomical differences between the child and adult that influence endotracheal intubation. Although the position for intubation (i.e., the sniff position) is the same for both adults and children, younger children have a much larger occiput in relationship to their body; therefore, a pillow under the head is often times not needed in a young infant or child. In fact, a towel under the child's back may be needed to gain optimal position for intubation. Furthermore, children have a so-called "high riding" epiglottis (that is, an epiglottis that corresponds to C₁ or C₂ compared to C₄ in the adult) and children have relatively large tongues; therefore a straight blade is usually indicated in the intubation of these children.

Endotracheal intubation in the child with suspected neck injury may be particularly troublesome. All too often, cervical radiographs are either not available or never totally "cleared" by the radiologist because the radiographs do not include adequate views below C₆ or views of the odontoid process (a common sight of fracture in children). Furthermore, pseudosubluxation of C₂-C₃ (anterior displacement of C₂ on C₃) or C₃-C₄ is common and, if present, could create a diagnostic dilemma. Also, children can suffer spinal cord injury with no radiographic abnormality. Therefore, patients with closed head injury should be treated as if they have unstable cervical spines.

Unless these children are severely obtunded, intubation without anesthetic agents ("awake" intubation) is usually impractical. Furthermore, laryngoscopy in the awake child is a potent stimulator of intracranial hypertension. Blind nasotracheal intubation is rarely successful due to the acute nasal-pharyngeal-laryngeal angles in children less than 8 years old and, if basilar skull fracture is present, may result in intracranial insertion. Fiberoptic intubation requires a prerequisite level of skill and is time consuming even in the best of hands and static conditions. Therefore, it has a limited role in the acute trauma situation.

Oral laryngoscopy under direct vision in the anesthetized child whose neck is being held in neutral position by axial immobilization usually allows successful endotracheal intubation.

In this technique, the head and neck are maintained in anatomical alignment with the body at the insertion of the assistant's fingertips under the child's mastoid processes and a gentle pulling effort in a straight cephalad line. Overly aggressive axial traction may cause further disruption of the cervical spine and should be avoided. Axial immobilization prevents the endoscopist from putting the child's head into extreme flexion or extension. A second assistant should apply cricoid pressure. If the child arrives with a cervical stabilization device in place, it may be carefully removed (while maintaining the head and neck position) to gain access to the child's larynx. It is safe to cautiously place a small towel under the shoulders if a younger child's relatively large occiput causes undue neck flexion that prevents adequate laryngoscopy.

Fluid Resuscitation

For initial fluid resuscitation, Ringer's Lactate (RL) is administered as a bolus (20 ml/kg). Boluses of RL may be repeated 3 times if vital signs fail to improve. If hypotension or shock continues despite the infusion of RL, either O negative or type specific red blood cells are administered (10 ml/kg increments). The child with significant hemorrhage who has required large volumes of fluid (30-40 ml/kg) to restore a stable hemodynamic status probably will require transfusion of red blood cells when they become available.

Restoration of volume in hypovolemic children with closed head injury almost always takes priority over raised ICP considerations. In order to maintain perfusion to the brain and other vital organs, it is of paramount importance to maintain the child's circulatory status. As in children without head injury, any isotonic crystalloid may be used for fluid resuscitation of children with head injury. Colloid provides no clinical advantages and is more expensive. Although Ringer's Lactate is not isotonic (RL=273 mOsm/L compared to normal saline = 308 mOsm/L), it may be used to resuscitate the child with multiple trauma and head injury. If given to the child in large amounts prior to arrival in the ER or OR, the serum osmolarity and hematocrit should be determined initially and at intervals and further fluid should be replaced with either RL, NS, or red blood cells.

The administration of mannitol for diuresis is followed by a triphasic response consisting of 1) hypotension, 2) increased blood volume, blood pressure, and possibly ICP, 3) and a return to normal blood pressure. Therefore, the administration of mannitol should be delayed until children are stable hemodynamically. When the patient is hemodynamically stable, loop diuretics may be given to augment the effect of mannitol.

Summary

In conclusion, the adult surgeon and anesthesiologist should assume roles to manage the two major considerations for traumatized

children: volume restoration and airway management. Usually, when both surgeon and anesthesiologist are present, the former gains vascular access and the latter secures the airway. With proper consideration for the smaller patient as discussed above, optimal cardiovascular and neurological outcome of these children can be accomplished.

APPENDIX

Glasgow Coma Scale

For Infants and Children

Best Motor Response

	<u>Score</u>
Obeys Commands	6
Localizes Pain	5
Withdraws From Pain	4
Abnormal Flexion	3
Abnormal Extension	2
Flaccidity	1

Eye Opening

	<u>Score</u>
Spontaneous	4
Opens to Voices	3
Opens to Pain	2
None	1

Best Verbal Response

(Modified For Children)

Appropriate Words or

Social Smile, Fixes 5
and Follows

Cries But Consolable 4

Persistently Irritable 3

Restless, Agitated

(Moans Only) 2

None 1

PAIN MANAGEMENT IN PEDIATRIC TRAUMA

Armin Rieger, M.D.
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Berlin, Germany

Pain management in children differs from pain management in adults. Children are rarely cooperative, they feel more pain, vein-cannulation is often difficult and there are some physiological differences.

For the same reason it is very difficult to estimate the extent of the trauma. In addition, children generally are very anxious. Reassuring by touching and talking to the child, involving the child's family members may help to ease the situation.

If analgesics are necessary the administration of the drug could pose a great problem. The intravenous route is the safest and fastest way to achieve pain relief but sometimes it is nearly impossible to establish an intravenous line. The intraosseous route could then be considered in children under five years.

Although rectal, oral, intramuscular or nasal application of analgesics is possible, their effect is unsafe and unpredictable. If the intravenous route is not possible, the nasal or intramuscular method seems to be next appropriate besides the

intraosseous way. Recent clinical research on nasal administration of opioids showed good results.

Distribution of intravenous agents may be affected by pharmacokinetic variables such as drug binding, volume of distribution, clearance and elimination half-life time which change with child's growth, so that dosage has to be individualized.

The type of trauma may also alter the physiology and pharmacology. After thermal injury, for instance, alteration in fluid compartments, cardiac output, glomerular filtration and hepatic perfusion and metabolism, reduction in albumin and increase in α_1 -acid-glycoprotein may occur.

Possible agents for pain therapy are non-narcotic analgesics like paracetamol (Tylenol) or ketamine and narcotics like Morphine, Fentanyl or Tramadol (narcotic analgesic distributed in Germany and Japan).

The choice of the appropriate analgetic depends on the type and extent of the trauma. In most cases it is necessary to use a narcotic drug.

The biggest disadvantage of narcotics is respiratory depression which may be more marked in children than in adults. Because of incomplete development of hepatic enzymes the

elimination half-life time may be longer. Intravenous doses of 0.1 mg/kg of Morphine or 1 mg/kg Meperidine (Demerol) produce good and long lasting pain relief.

Fentanyl, a synthetic opioid with a potency of 50 to 100 times that of Morphine provides sufficient but short lasting pain relief in an intravenous dose of 1 to 10 ug/kg.

The non-narcotic drug Ketamine produces effective analgesia. The usual dose is 2 mg/kg for intravenous and 6 mg/kg for intramuscular administration. Ketamine increases heart rate, blood pressure and cardiac output (a valuable adjunct in pain management of the injured child). Ketamine also increases intracranial pressure under spontaneous ventilation and must be used with caution in children with head injury.

An alternative method of acute pain management is to practice any kind of nerve block. For example, femoral nerve block after dislocation of the hip or axillary block after bone fracture in the forearm.

Pain management in pediatric trauma must be effective and requires knowledge of the physiology and the pharmacology of the available drugs in the injured child.

TRANSPORTING THE CRITICALLY INJURED CHILD:
THE FRENCH POINT OF VIEW

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Transport of the critically injured children represents a unique challenge for physicians involved in emergency medicine. In France, education in the field of emergency medicine is mandatory for anesthesiology certification. Transports of traumatized patients from the field to the hospital or from one hospital to another are performed by medical teams including a physician trained in emergency medicine, and frequently in anesthesiology and critical care. We will review the principles of organization for this kind of transport.

Scene management and transport to the hospital

Medical management of traumatized patients is provided at the scene by MICU teams of the SAMU. ATLS is initiated and field stabilization is mandatory before transportation except in the presence of untractable hemorrhagic requiring immediate surgical hemostasis, that represents a rare situation in children. Management begins with initial evaluation with complete physical examination, field triage with validated scores such as Glasgow

coma scale (GCS), Pediatric Trauma Score (PTS) and revised trauma score (RTS). The basis of ATLS performed at the scene are:

- 1) Insertion of intravenous line in all the cases and fluid loading with colloids when indicated
- 2) Airway control by tracheal intubation in all the patients with a GCS \leq 8 and/or a PTS \leq 7. Standard of care includes controlled ventilation with portable volume limited ventilators and adapted to pulse oximetry and capnography. This equipment is available in MICU ambulances.
- 3) Special stretchers with vacuum mattress and cervical collars are used for spine immobilization in all the patients.
- 4) Analgesia using simple peripheral nerve blocks or intravenous anesthesia when indicated is an important part of the scene management. Further management such as thoracocentesis for tension hemothorax, IV drugs administration or MAST-suit application can be performed at any time.

The aim of this kind of management is to initiate out-of-the hospital high level of acute trauma care in the same way as it could be provided by a trained receiving team upon arrival to the hospital in good conditions and saves time for the receiving team. Receiving hospital's team is activated and informed of the patient's status and its evaluation by direct telephone contact between receiving physicians and field physician.

Inter and intra-hospital transportation

Estimated length of transportation, possible hazards of transporting a critically injured patient, special conditions related to air transportation, need for continuing critical care and portable monitoring equipment must be carefully evaluated before transport. One of the most important rules is to initiate transport only on a stabilized patient and to avoid patient deterioration. Guidelines for inter or intra-hospital transports must be the same as those used for acute field management. This is particularly true for pediatric population. Qualified personnel such as an anesthesiologist or a trained emergency physician must be involved in the care of these children at any time, during long lasting air or ground transports as well as during intra-hospital transfer for diagnostic procedures.

The aim of transportation of critically injured children is to provide a continuity in critical care at any time. This goal is best achieved by specially designated medical teams using sophisticated equipment and including trained physicians. These physicians must be able to provide a high level of ATLS at any place: not only in hospital emergency and critical care departments, but also in unprotected areas such as accident scene, ground and air ambulances or in the corridors of a hospital.

PROCEDURES IN PEDIATRIC LIFE SUPPORT

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The management of a critically ill or injured child requires a systematic, well rehearsed approach that can be instituted almost reflexively. One must be able to identify the management priorities for stabilization of the patient even before a complete history and physical examination have been obtained. Indeed, definitive therapy may not be possible until resuscitation and stabilization are complete. When dealing with children, success is only possible if the unique, physiologic and pathophysiologic responses of the children are understood by the resuscitation team.

As anesthesiologists we have a special role in the management of critically ill and injured children as well as in the education of our colleagues in pediatric medicine and surgery. We possess specialized knowledge and skills in pharmacology and physiology and in airway, pulmonary, and cardiovascular resuscitation. Sometimes, however, resuscitation and emergency techniques that are well known to our colleagues are unknown to us. In the following discussion, I'll highlight some of the newer advances in pediatric resuscitation, that may be of use both in and out of the operating room.

SHOCK AND FLUID RESUSCITATION

Shock is a syndrome of acute homeostatic derangement of various etiologies, involving multiple organ systems, which ultimately causes failure of cellular metabolism.

SPECIAL TECHNIQUES IN SHOCK

Military Anti-Shock Trousers (MAST)

Indications and Contraindications

Hypotension from shock of any etiology can be treated with the MAST. Indications include BP < 70 in children > 2. The MAST provides a method of immediately shunting blood to vital organs, even before volume replacement can be given. It is useful for the control of intra-abdominal, pelvic and lower extremity bleeding. Pulmonary edema is the one absolute contraindication to the application of the MAST. Head trauma is a relative contraindication.

Inflation:

The MAST is inflated until BP is adequate. Check valves in the suit will prevent over inflation.

Intravenous Fluid Replacement:

After application of the MAST, large bore IV catheters are inserted above the trousers and Ringer's lactate and blood are given as needed.

Deflation and Removal:

The trousers are deflated in a gradual process starting with the abdominal segment. Deflation is stopped when BP drops by 5 mm HG. IV fluid replacement is then increased. After the abdominal segment has been deflated, the legs are each deflated in a similar fashion. If the patient requires transfer to another facility, the MAST is left in place for transport.

Vascular Access

Vascular access must be obtained immediately in emergency situations. When IV access cannot be obtained in 90 - 120 seconds in children < 5 years of age, the INTRAOSSEOUS route of fluid and drug administration is used. In this technique, a luer locked bone marrow needle (e.g., Cook Inc.) is inserted in the proximal tibial shaft. The intramedullary space is directly contiguous with the intravenous compartment, so that fluid and drugs readily pass to the central circulation following intraosseous administration. In older patients either a saphenous vein cutdown or central venous access is obtained. All of these techniques will be demonstrated, particularly the landmarks for internal jugular cannulation in infants and small children, subclavian and femoral venous access, and axillary venous (and arterial) catheterization. We will also demonstrate the basis of how to perform a venous cutdown,

particularly when the vein is smaller than the suture you are using to hold it.

Monitoring

The most important monitors in assessing the adequacy and quality of circulation in children include:

Capillary refill (< 2 sec), toe (finger) temperature (should not be < 2 C° below core body temperature), urine output (must be better than 0.5 ml/kg/hr) and mental status. Blood pressure, heart rate, CVP are much less reliable indicators of the adequacy of circulation. Tricks of monitoring peripheral temperature and its importance will be demonstrated.

"FAILURE TO RESPOND"

When there is a failure to respond to administered therapy, one must consider the following: ventilatory problems (hypoxia, hypercarbia, pneumothorax, see below), unrecognized fluid loss (intra-abdominal, extremity fracture), acute gastric distension, cardiac tamponade, myocardial contusion, diabetic acidosis, hypoadrenalism.

Tension Pneumothorax

A tension pneumothorax is by definition an accumulation of air under pressure in the pleural space. Early signs include dyspnea,

INTRAOSSSEOUS INFUSION

Jeffrey M. Berman, M.D.
The Bowman Gray School of Medicine
Wake Forest University Medical Center
Winston-Salem, North Carolina

Background:

- 1922: Drinker et al: Described circulation in mammalian bone marrow
1934: Josefson: I.O. route for medicinal purposes
1940: Tocantins: Demonstrated rapid absorption into general circulation of substances injected into sternal and tibial rabbit marrow.
1941-44: Tocantins: Human series demonstrating efficacy.

Anatomy and Physiology:

Circulation of marrow - Emissary (intramedullary) vessels
Emissary veins remain open in shock

Indications:

Need for emergent vascular access
circulatory collapse
cardiac arrest

Contraindications:

- Osteogenesis imperfecta
- Osteopetrosis
- Fracture
- Local infection

Method:

- Sterile prep
 - Aseptic technique
 - Local anesthetic
- Proximal tibia - anteromedial surface 1-2 cm below the tibial tuberosity
Distal femur midline in lower 1/3 approximately 3 cm above external condyle

Needles:

Hypodermic
Butterfly
Spinal
Bone Marrow
Interosseous needle

Technique:

- After prep and local anesthesia
- Penetrate skin
 - Direct needle at slight (10°) angle (caudal for tibia; cephalad for femur)
 - Apply constant pressure with rotating motion
 - Loss of resistance with passage from cortical bone to marrow
 - Aspirate marrow to confirm placement
 - Flush
 - Connect to IV

Complications: (Potential)

- Failure to secure access
- Abscess
- Extravasation
- Penetration of both cortices
- Epiphysial injury
- Osteomyelitis
- Local inflammatory response

Summary:

- Old technique
- For Emergency
- Temporizing measure
- Safe
- Quick
- Easy

SIMULTANEOUS SESSION III.

Level One Trauma Anesthesia Simulations (LOTAS)

This session will follow a trauma patient from the field to discharge from the operating room using real video tapes to illustrate patient management protocols, stressors, decision-making, errors and real-life events associated with resuscitation and anesthesia for trauma. The equipment used will be described and video analysis techniques discussed.

Moderator-in-Chief: Colin F. Mackenzie, MD

Field Video Tapes

Yoel Donchin, MD

Transport Video Tapes

Yoel Donchin, MD

Frances Forrest, MD

Resuscitation Video Tapes

Colin F. Mackenzie, MD

Operating Room Video Tapes

Colin F. Mackenzie, MD

Frances Forrest, MD

**Effects of Fatigue and Experience on
Performance**

David Gaba, MD

Analysis of Audio Communications

Richard Horst, PhD

**Setting Up a Video Acquisition and
Analysis System**

Colin F. Mackenzie, MD

LEVEL ONE TRAUMA ANESTHESIA SIMULATIONS

FIELD VIDEO TAPES

Yoel Donchin, M.D.

I. The Use of a Video Camera in the Field - Is it Legal?

II. The Influence of the Camera on the Trauma Team

III. The Ethics of Recording by a Member of the Team

IV. What Can We Learn from a Video?

V. Human Errors

VI. Performance

VII. Job Analysis

VIII. The Video as a Substitute for Recording Data

**TRANSFER OF PATIENTS FROM THE HELIPAD TO THE ADMITTING AREA AT
THE MIEMSS SHOCK TRAUMA CENTER**

Frances Forrest, M.D.

I. Introduction

A. Brief Outline

1. Routes of Admission to Shock Trauma Center
2. Patient Information Prior to Arrival (Trauma Line and SYSCOM)
3. Example of Information Given (Using Subject in Video)

II. Video Presentation

A. Video Presentation with Transcript (4 Minutes)

1. Use Relevant Sections of Video

B. Collecting the Transfer: Expect the Unexpected!

1. Shock Trauma Center Staff to Helicopter (Who and With What)
2. First View of Patient (Visual info on Patient Only - NOISE)
3. Patient Out of Helicopter

III. Patient Admission Protocol Analysis

A. During Transfer to Admitting Area

1. Superficial Evaluation of Patient by Shock Trauma

Center Staff

2. **Conflicting Instructions Between Shock Trauma Center Staff**
3. **Appropriate Information from Field Personnel to Shock Trauma Center Staff (Critical Information About the Prone Position Given Last)**

B. Arrival in Admitting Area

1. **Stress Factors on Anesthesia Personnel**
2. **Whay They Did**
3. **Was it Right?**

IV. Interpretation

A. Conclusion

1. **Summary of Salient Points that we Learned from this Video Analysis**
2. **Use of Video Tapes in Medical/Trauma Education**

RESUSCITATION AND OPERATIONS FOR VIDEO TAPES

Colin F. Mackenzie, M.D.

I. Emergency tracheal intubation - Analysis

A. Difficult Airway Algorithm and Reality

- 1. Video Tapes of Difficult Airway**
- 2. Analysis of Emergency Airway Management**

II. Admitting Area

A. Team Interactions

- 1. Resuscitate vs. No Resuscitate**
- 2. Anesthetize vs. Neurological Exam**

B. Group Decision-Making Under Stress

- 1. Resuscitation Domain**
- 2. Role of the Team Leader vs. Anesthesiology Team**

III. Differences Operating Room vs. Admitting Area

ANALYSIS OF AUDIO COMMUNICATIONS

Richard L. Horst, Ph.D.

I. Importance of Team Interactions in Decision-Making

- A. Group Decision-Making: Influence of Group on the Decision-Maker, Reluctance of Subordinates to Speak Up**
- B. Errors - Examples from Shipboard, Cockpit**
- C. Non-Optimal Performance -- Anecdotes From Video Tapes**
- D. Stress Caused by Contentious Interactions -- Anecdotes From Video Tapes**

II. Our Interests

- A. Verbilization as Measures of Team Performance, Efficiency**
- B. Verbilization as the Cause vs. Effects of Stress**
- C. Vebilization as Indicants of Decision-Making**

III. Methodology

- A. Video Taping in Admitting Area and Operating Room, Position of Microphones**
- B. Video Analysis: Communications Coding**
- C. Relate Communications to Post-Trauma Treatment Questionnaire, Stressor Ratings, Structured Interviews, Physiological Data from Patient's Vital Signs**

IV. "Experimental Design" in Naturalistic Trauma Treatment: Effects of Stress

- A. Pre -, During, and Post-Intubation
- B. Elective vs. Emergency Intubation Cases
- C. Related Communications to Severity of Injury
- D. Relate Communications to "Overall" stress Ratings

V. Results

- A. Incidence and Type of Task-Relevant Communication
- B. Incidence and Type of Non-Task-Relevant Communications
- C. Tell-Tale Comments Regarding Stress, Confusion, Non-Optimal Performance, Non-Optimal Task Allocation
- D. Verbalizations as the Effects of Stress vs. the Cause of Stress

VI. Discussion

- A. Implications for Team Performance Measurements
- B. Implications for Modeling Team Decision-Making
- C. Implications for Trauma Treatment Training

SETTING UP A VIDEO ACQUISITION AND ANALYSIS SYSTEM

Colin F. Mackenzie, M.D. and Richard L. Horst, Ph.D.

I. Video Acquisition

A. Equipment

- 1. Cost**
- 2. Installation**

B. Consent

- 1. Anesthesiologists/CRNA's**
- 2. Others**

C. Interfacing

- 1. Monitors**
- 2. Network**

II. Data Collection

A. Video overlay

- 1. Boards**
- 2. Which Data?**

B. Time Code Generation

- 1. Physiological Data**
- 2. Video Tape**

C. Automation

- 1. Turn Key**
- 2. Trouble Shoot**

III. Data Analysis

A. Equipment

B. Software

VI. Techniques of Video Analysis

A. How Many Passes?

B. What Information?

SUMMARY PANEL

- I. A. Elective Tracheal Intubation**
 - 1. Comparison with Emergency**
 - 2. Differences in Stressors**

- II. Use of Patient Physiological Data**
 - A. Decision Trees for Abnormalities in Patient's Physiological Data.**
 - 1. Tachycardia**
 - 2. Hypotension**
 - B. Other Decision Trees**

- III. Teaching in the Operating Room and Admitting Area**
 - A. Emergency Intubation**
 - B. During Operating Room Management**

- IV. What are the Stressors for the Trauma Anesthesiologists?**
 - A. Difficulties**
 - 1. Identification**
 - 2. Weighting of Relative Stressors**
 - B. Cognitive Assumptions**

- V. Synthetic Work Environment (SYNWORK) to Assess Performance**
 - A.**
 - 1. Fatigue on Shiftwork**

2. Sensitivity and Specificity of SNYWORK

VI. Summary of Video Analysis of Resuscitation and Trauma
Anesthesia

SIMULTANEOUS SESSION IV.

Trauma Anesthesia Research: Scientific Posters

During this session participants will be available to discuss their posters. An award will be given for the best presentation.

The presentations will be judged on the basis of content, scientific content, and artistic effort.

Moderator-in-Chief: Enrico M. Camporresi, MD

Moderators: Pierre A. Carli, MD

Levon M. Capan, MD

Bruce F. Cullen, MD

Adolph H. Giesecke, MD

Ronald G. Pearl, MD, PhD

SCIENTIFIC POSTERS

Friday, May 21, 1993

Management of Intra-Hospital Critical Care Transport: Unification of Equipment and Policy

The Interactions of Ethanol and Phenobarbital on the Binding of Vecuronium of Rat Liver Cytochrome P450

Possible Beneficial Role of High Doses of Aprotinin in the Prevention and Therapy of Bleeding Acute Erosive Gastritis-Preliminary Communication

Hemodynamic Comparison of Endotracheal Intubation: Macintosh Laryngoscope Versus Augustine Guide

Prehospital Use of Active Compression Decompression During ACLS

Clinical Utility of Body Temperature Modalities in Assessing Hypothermia in the PACU: Comparison of the Sensitivity, Specificity, Accuracy, and Precision of Methods

Morphine Use in Severe Injury: A Case of Homoeopathy

Posterior Fossa Hematoma and Streptococcal Meningitis: A Concurrent Presentation
Techniques in Airway Management

Detecting Alcoholism in Trauma Patients

The Potential for Venous Air Embolism From One Liter Crystalloid Bags

Anesthetic Considerations in Diagnostic Laparoscopy for Abdominal Stab Wounds: Preliminary Observations

Analysis of Arterial to End-Tidal Carbon Dioxide Gradients in Ventilated Trauma Patients

Blind Oral Intubation: A Safer Alternative for Airway Management in Patients with Cervical Spine Injury?

Asynchronous Independent Lung Ventilation in Monolateral Lung Traumatic Disease: A Case Report

Clinical Side Effects of a Rapid Infusion of 7.5% Hypertonic Saline in Conscious Patients

Acute Neurologic Injury: Cardiovascular Response to Emergency Intubation

Complications of Re-Intubation Following Self-Extubation

Diagnosis of Thoracic Spine Injury in Chest Trauma

Changes in Arterial End-Tidal PCO₂ Difference and Physiological Deadspace During Hemodynamic Alterations

Preventable Deaths in Victims of Major Trauma

Pedestrian Accidents, Injuries and Care in North West Britain

Audit of Multiply Injured Patients in North West Britain

A Review of Pediatric Trauma in North West Britain

Clinical Tolerance of High Doses of Hydroxocobalamin (HOCO) in Fire Cyanide Poisoning Victims

Phenomenon of Erythrocytes Redistribution of Different Aged Fractions and Its Role In the Correction of External Conditions

MANAGEMENT OF INTRA-HOSPITAL CRITICAL CARE TRANSPORT: UNIFICATION OF EQUIPMENT AND POLICY

M.E. Banchik, MD; G. Blumberg, RRT; Departments of Anesthesiology and Respiratory Therapy, Mount Sinai Services at Elmhurst Hospital Center, Elmhurst, NY, and The Mount Sinai School of Medicine of The City University of New York, New York, NY.

The ability to monitor potentially hemodynamically unstable patients has undergone major enhancement during the past few years. While much attention has been focused on the extra-hospital and peri-operative phases of transport and monitoring, little work has been done to evaluate the intra-hospital transport [IHT] phase.

It has been previously noted that the IHT is a period of great potential danger to the ventilator dependant patient due to frequent patient repositioning and repeated disconnection/reconnection of monitor and ventilatory devices. The transport teams attention is focused on physical movement of the patient and monitoring is often sub-optimal. To address the issues of patient safety as well as practicality in transport management, Elmhurst Hospital Center has devised a High Risk Critical Transport policy which has been in use for over 5 years. Two Critical Care Stretchers [CCS] are employed at the present time.

Patient Selection Criteria:	Cardio-pulmonary instability Need for continuous mechanical ventilation Need for diagnostic/therapeutic procedures which cannot be done at bedside
Staff Requirements:	Physician (ACLS certified) Respiratory Therapist [RT] 2 Transport Aides [TA]
CCS Equipment Design:	Heavy duty transport stretcher Defibrillator Suction pump Drug box and Intubation kit Ventilator & O2 tank(s) Combined ECG/Pulse Oximeter/Respiration/Non-Invasive & Invasive BP monitor with internal batteries 12VDC Battery for ventilator/110VAC Recharging unit
Procedure:	Referring Physician requests CCS for patient transport Patient evaluated by CCS team as to hemodynamic and respiratory stability in relation to need for transport RT prepares CCS for patient use RT and 1 TA bring CCS to patient Physician, RT and 2 TA's accompany all patient moves At end of move disposables changed, QA/CCI evaluation completed and 110VAC line power restored

On analysis of over 1665 CCS movements during a 4 year period based on QA/CQI data, there have been no occurrences of IHT extubation or unrecognized hemodynamic instability. It is the consensus of staff involved that CCS success is due to the unified design of transport/monitoring equipment with coordinated hospital policy and QA/CQI overview.

THE INTERACTIONS OF ETHANOL AND PHENOBARBITAL ON THE BINDING OF VECURONIUM TO RAT LIVER CYTOCHROME P450

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Approximately 50% of all trauma is associated with ethanol (EtOH) intoxication. This is not surprising since EtOH is a drug frequently used in our society. In fact, it is estimated that 20 million people use EtOH chronically. It has been pointed out that EtOH-drug interactions are quite complex¹. Cytochrome P450 (P450), a major enzyme system responsible for the metabolism of many anesthetics and muscle relaxants, not only metabolizes EtOH, but is also induced by EtOH. EtOH ingestion can have paradoxical effects on drug metabolism. In the presence of alcohol, drug metabolism can be depressed because EtOH competes with drugs at the P450 level². However, in the absence of alcohol (acute abstinence) but after chronic EtOH intake, drug metabolism is increased because of the induction of total P450 by EtOH. Likewise, other substrate/inducers of P450 (eg phenobarbital) can have paradoxical effects on drug metabolism. Consequently, drug therapy for the alcoholic or alcohol-using patients must be carefully evaluated. Binding studies were used to characterize the interactions of EtOH and vecuronium (VEC) with P450.

METHODS: Male, Sprague-Dawley rats were pretreated with pyrazole (PYR), an inducer of the alcohol P450³, or phenobarbital (PHENO), an inducer of P450 2B1, and hepatic microsomes were prepared as previously described³. Substrate binding spectra were obtained by the method of Peterson *et al*⁴. Kinetic constants were obtained using linear regression analysis of Hanes-Wolfe plots. Protein was determined by the method Lowery *et al*⁵. Data were analyzed using a Student's t-test (one tailed, unpaired). $P < 0.05$ was considered significant.

RESULTS: The binding of VEC to hepatic microsomal P450 was concentration dependent and resulted in a type I binding spectrum with a peak at 384-386 nm and a trough at 416-418 nm. Maximum binding capacity as expressed as the absorbance difference (385-417 nm) (ABS) max per mg protein was 2-3 fold higher in phenobarbital microsomes. The addition of 5mM EtOH significantly increased the Ks for VEC in saline (control) and PYR microsomes, but not in microsomes pretreated with PHENO.

CONCLUSIONS: 1)The interactions of ethanol and drugs are complex and are not predictable. 2)VEC has a greater affinity for binding to alcohol P450 than P450 2B1. 3)Ethanol *in vivo* can inhibit the binding of VEC to alcohol P450 as shown by the increase in Ks; however, this effect is not seen with PHENO induced of P450. 4)If binding correlates with actual metabolism, these results suggest that the metabolism of VEC may be decreased by presence of ethanol in specific populations of P450 and may have significant implications in the anesthetic management of trauma patients.

REFERENCES: 1) Biochem Pharm 1976;25:869. 2)Science 1971;172:1097. 3)Biochem Pharm 1987;19:3277. 4)Oxidases and Related Redox Systems. Univ. Park Press 2:565. 5)J Bio Chem 1951;193:265.

Treatment	ABS max/ mg protein	Ks(uM)	Ks with 5mM EtOH	% Change
Saline	0.020±0.003	50±6	78±6 ^a	+56
PYR	0.024±0.003	74±5	108±14 ^b	+46
Pheno	0.063±0.007	873±55	1018±195	+17

X±SEM ^a $p < 0.009$ ^b $p < 0.04$

POSSIBLE BENEFICIAL ROLE OF HIGH DOSES OF APROTININ IN THE PREVENTION AND THERAPY OF BLEEDING ACUTE EROSION GASTRITIS - Preliminary communication.

Zoran Vukcevic, Department of Surgery, Clinical Center Podgorica (Titograd), Montenegro, Yugoslavia; and Snezana Pavicevic, I.C.U.

Acute injury of the gastric mucosa - erosive gastritis - is the most common cause of upper gastro intestinal bleeding, and by far most frequent pathologic process within the stomach. Acute erosive gastritis occurs relatively frequently in the setting of severe illness, or following physical or thermal injuries, sepsis or shock, and then it is called -"stress" erosive gastritis.

On the basis of several clinical experiences with successful outcome, I postulated a hypothesis that aprotinin is beneficial in the prevention of stress erosive gastritis, and that high doses of this drug added in the therapy for acute bleeding gastric erosions reduces significantly blood losses and need for surgery. It appears possible that aprotinin has twofold mechanism of action in the setting of acute bleeding gastric ulcerations:

1. Hemostatic effect of aprotinin is realized through:

- Preservation of platelet function, already proved to be a significant contribution toward blood conservation, especially in "bleeding" surgical procedures.

- Antifibrinolytic effect of aprotinin probably highly positively affects the course and outcome of this disorder. Promising results have been reported in the treatment of gastric and duodenal bleeding with antifibrinolytic tranexamic acid.

2. Antipeptic effect of aprotinin probably cannot solely be sufficient for pepsin inactivation, because of low binding affinity of clinical doses of aprotinin for pepsin, but added to antacids and H₂-blockers, aprotinin surely improves their efficiency.

This hypothesis should be definitely tested and best judged in a prospective placebo-controlled, double-blind clinical trail.

HEMODYNAMIC COMPARISON OF ENDOTRACHEAL INTUBATION: MACINTOSH LARYNGOSCOPE VERSUS AUGUSTINE GUIDE™

A Kovac, J Maye, G Devane, J Calkins. Departments of Anesthesiology and OB-GYN, University of Kansas Medical Center, Kansas City, KS.

Oral laryngoscopy and endotracheal intubation (ETI) cause an increase in heart rate (HR) and mean arterial pressure (MAP). The Augustine Guide™ (AG), a new device designed for blind intubation, and is composed of an intubation guide and esophageal detector stylet (Fig. 1). Hemodynamic response comparison between the Macintosh laryngoscope (ML) and the AG has not been previously reported. Purpose: To compare the hemodynamic response to ETI using the ML (direct vision, oral) versus the AG (blind, oral).

Following IRB approval and written consent, study patients (24) were ASA class I-III females, Mallampati airway class I-II¹ scheduled for outpatient gynecological surgery under general anesthesia. HR was monitored by EKG and MAP by automated cuff. All patients were preoxygenated for 5 min prior to induction (IND) of anesthesia and received alfentanil 10 mcg/kg 5 min prior to IND with pentothal 5 mg/kg and succinylcholine 1 mg/kg. Patients (n=12 in each group) were intubated with ML or AG in a randomized prospective design. Post-ETI, N₂O/O₂ and Forane were administered. HR and MAP were measured at baseline and at min 1-6 post IND (time zero). Time to ETI was noted. ANOVA followed by Newman-Keuls multiple comparison test was used to analyze data. A p<0.05 level was set for statistical significance.

The mean age (\pm SD) was 35 \pm 13 years and mean weight was 69 \pm 14 kg. Time to ETI was significantly longer with AG (91 \pm 55 sec) than ML (24 \pm 6 sec); however, there was no difference between groups in HR (Fig. 2) or MAP (Fig. 3). In the ML group, there was a significant difference between HR at baseline and minutes 1-5 post IND (Fig. 2).

The hemodynamic response to oral laryngoscopy and ETI begins within 15 sec and is maximal at 45 sec.² Hemodynamic response to ML and AG regarding HR and MAP was similar between groups, even though time to ETI with AG was longer than with ML. Compared to baseline, AG had less of an effect on HR than ML. The AG is an additional technique to achieve endotracheal intubation with a comparable MAP and less of a HR response than the ML.

¹Can J Anaesth 1985;21:429-34. ²Anesthesiology 1977;47:381-4.

Figure 1. Components of the Augustine Guide™

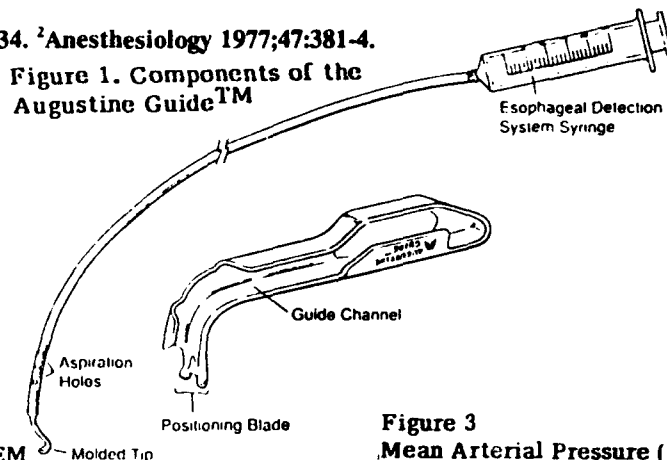


Figure 2

Heart Rate (n=12) Mean \pm SEM

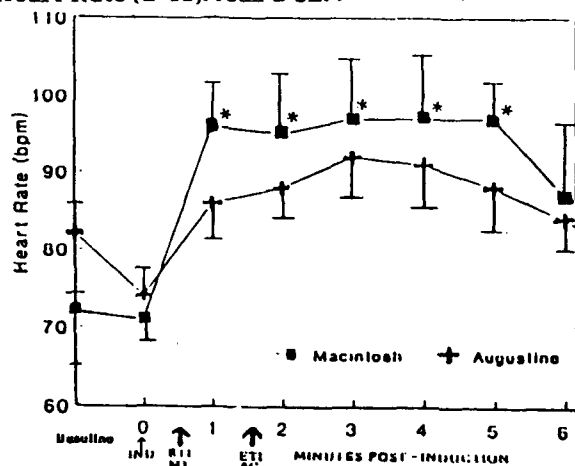
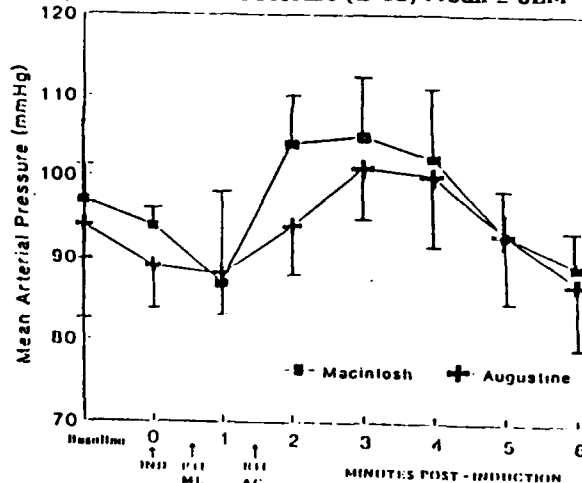


Figure 3

Mean Arterial Pressure (n=12) Mean \pm SEM



PREHOSPITAL USE OF ACTIVE COMPRESSION DECOMPRESSION DURING ACLS

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The aim of this study was to assess the faisability and the efficiency of the ACD method (Cardio Pump* Ambu) during ACLS in the field.

Methods : 15 consecutive patients were studied. They received ACLS performed by a medical team including an anaesthesiologist and following the AHA guidelines. The parameters studied were the plugger dislodgment from the chest, the easiness cardiac massage, the interference with the other components of CPR. The efficiency was assessed by the perception of a femoral pulse during CPR, the return of spontaneous circulation (ROSC) and the number of patients admitted alive at the hospital. In seven out the 15 patients ETCO₂ was measured and in 5 of them ETCO₂ during ACD was compared to the value obtained during standard CPR.

Results : Cardiac massage with the Cardio Pump* was considered as simple and safe by the large majority of the users. No direct adverse effect related to the method was observed. A pulse during CPR was obtained in 14 of the 15 patients, ROSC in 7/15. Five patients (30%) were admitted alive. When ETCO₂ was recorded an increase during ACD was observed as compared to standard CPR.

Conclusion : This non randomized, non blinded study only suggest that the use of ACD is simple and efficient. Further studies are needed to compare the efficiency of this new technique with other classical methods.

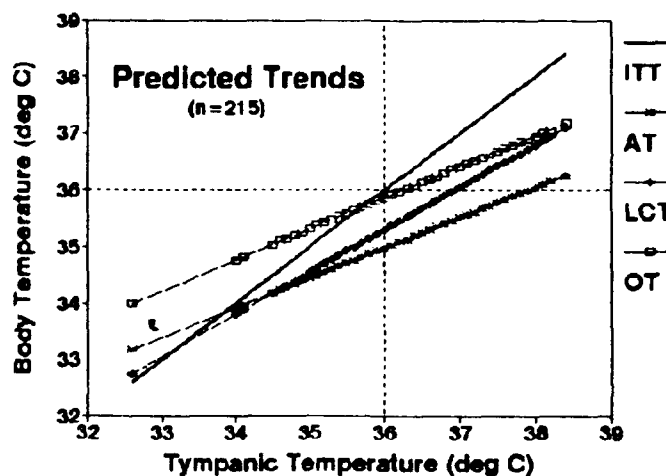
CLINICAL UTILITY OF BODY TEMPERATURE MODALITIES IN ASSESSING HYPOTHERMIA IN THE PACU: COMPARISON OF THE SENSITIVITY, SPECIFICITY, ACCURACY AND PRECISION OF METHODS

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Within the past decade new patient temperature monitoring devices have been introduced in the Post Anesthesia Care Unit (PACU) to assist in patient management and to assess the risk for hypothermia. Although previous investigators have correlated patient body temperature (BT) obtained from new methods with reference standards, there has been a paucity of research which has critically assessed the sensitivity (SEN), specificity (SPEC) and accuracy (ACC) of these modalities for identifying clinically significant hypothermia. This study measured BT with four techniques in 30 control subjects ($\sigma^2=13:17$; mean \pm sd age = 35.4 ± 7.1 yrs) and 215 patients ($\sigma^2=93:122$; mean \pm sd age = 45.2 ± 19.6 yrs) in the setting of a PACU (ambient temperature $22.9 \pm 1.3^\circ\text{C}$). BT methods included infrared tympanic (ITT), oral (OT) and axillary (AT) thermistor, and forehead core temperature corrected liquid crystal displays (LCT). OT, AT and LCT were compared with ITT since ITT has been shown to reflect hypothalamic temperature. Hypothermia in the PACU environment was defined as BT $< 36^\circ\text{C}$. Precision was defined by the coefficients of variability in the control group and was 0.01 for ITT, OT and AT, and 0.02 for LCT. Regression analyses for patients demonstrated significant correlations ($p<0.001$) between ITT and other techniques; however, regression slopes differed ($p<0.01$) from the line of identity.

Regression Analyses ($^\circ\text{C}$)	$r =$
$\text{OT} = 0.548\text{ITT} + 16.1$	0.645
$\text{AT} = 0.533\text{ITT} + 16.8$	0.485
$\text{LCT} = 0.745\text{ITT} + 8.4$	0.605

	SEN	SPEC	ACC
OT =	0.79	0.69	0.28
AT =	0.97	0.25	0.34
LCT =	1.00	0.47	0.31



Results suggest that LCT had the least precision for determining BT. OT had the highest SPEC for hypothermia and correlated better with ITT than LCT or AT. It is of interest to note that the BT devices evaluated appeared to have a low accuracy for detecting clinically significant hypothermic events, suggesting that the temperature criteria employed to define hypothermia may be modality dependent.

MORPHINE USE IN SEVERE INJURY: A CASE OF HOMEOPATHY

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³Department of Surgery, Arizona Health Sciences Center, Tucson, AZ. ⁴Department of Pharmacy Practice, University of Arizona, Tucson, AZ. ⁵Department of Clinical Pharmacy, University of Tennessee, Memphis, TN.

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PURPOSE: Inadequate pain management can result in adverse consequences. We hypothesized critically ill trauma patients receive small doses of morphine infrequently. As a preliminary study we evaluated the patterns of intravenous morphine use in trauma patients.

METHODS: Five trauma centers participated in this multi-site study. Consecutive trauma patients admitted to the ICU within twelve hours of injury and who received intravenous morphine were evaluated. Patients with a Glasgow coma scale < 8, spinal cord injury, or concurrent administration of other narcotics or NSAIDs were excluded. Data obtained from the first four nursing shifts included: morphine regimen prescribed, actual amount administered, and number of doses administered per shift. **RESULTS:** 1066 doses in 118 patients during 415 shifts were evaluated. The median injury severity score (ISS) was 16 (range 1-75), indicating severe injury. The average dose actually administered was 4 mg (range 1-10 mg). 44% of doses administered were at or below the minimum prescribed by the surgeon. During 80 shifts no morphine was administered. 78% of patients received their dose at intervals on average two hours or longer. There was no correlation between morphine dose ordered and ISS or dose given and Glasgow coma scale. **CONCLUSIONS:** Acutely injured trauma patients, regardless of severity of injury or mental status, receive only small amounts of morphine. We suspect the pain was inadequately treated since the doses are so low and so infrequently administered.

POSTERIOR FOSSA HEMATOMA AND STREPTOCOCCAL MENINGITIS: A CONCURRENT PRESENTATION

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INTRODUCTION: Epidural hematoma in the posterior fossa is rare and often not suspected when traumatic head injury occurs. Several large studies suggest that 0.2 to 0.3% of traumatic, space occupying hematomas occur in the posterior fossa.^{1,2} Other studies suggest that 50% of these are extradural.³ Even more rare is the occurrence of meningitis concomitant with an epidural hematoma. An exhaustive search of the literature reveals no previous published reports of this unusual combination. The present case documents an initial recording of posterior fossa epidural hematoma which presents in combination with pneumococcal meningitis.

CASE REPORT: Our patient is a 35 year old American Indian male who tripped over a curb and fell and hit the back of his head and briefly lost consciousness. He complained of headache and presented the following day to another hospital with complaints of headache and difficulty walking. CT scan performed at that time was reported as normal. He was observed for six hours then released. He continued to have pain and increasing difficulty walking the remainder of the day. He became increasingly somnolent until the next day when he was unable to get out of bed. He was brought to our facility by ambulance the next morning.

Physical examination showed a well developed, thin male who was in a moderate amount of distress. He opened eyes spontaneously but was either unwilling or unable to talk. On occasion he would grab for his head with accompanying facial grimacing. Some nuchal rigidity was present. Pupils were 3-4+/4+ and very brisk. Neurologic examination showed the patient to be very uncooperative. He withdrew from pinprick in all extremities. Unable to assess Babinski due to patients withdrawal. Labs on admission showed a white blood cell count of 45,700 with 59% neutrophils and 34% bands. Repeat CT scan showed a radiodense lesion in the left occipital area. A craniotomy was performed in the area of the right posterior fossa. An epidural hematoma was evacuated uneventfully and the patient was transferred to the ICU. A lumbar puncture was performed. Cell count showed 1100 RBC's and 8900 WBC's with 94% neutrophils, 2% lymphocytes, and 4% monocytes or histiocytes. Gram stain showed many neutrophils and many gram positive diplococci suggestive of *Streptococcus pneumoniae*. The patient was begun on 3,000,000 units of penicillin G every four hours and Vancomycin, 1 gram every twelve hours. The patient progressed well during his hospitalization and was released on post operative day number nine.

DISCUSSION: Epidural hematoma in the posterior fossa is rare and an often neglected diagnosis when brain injury occurs. Overall, less than 200 cases have been published since 1901.^{1,5} CT scanning has caused a real revolution in the diagnosis and early management of subtentorial extradural hematoma. Before the development of the CT scanner, only the appearance of cerebellar symptoms or the involvement of one or more lower cranial nerves indicated that such a lesion might exist. Prior to 1975, a mortality rate of 75-100% was common.^{6,7} Survival rates of 50-70% are prevalent since a precise and early diagnosis of this type of brain injury has been made possible.⁸

Mortality remains high, although an improvement has occurred since the CT scan was introduced. Mortality rates continue around 20-50%.^{9,10} High mortality is caused less by the hematoma itself than by concomitant injuries of the brainstem or basal ganglia.

CONCLUSION: We have presented here a case of posterior fossa epidural hematoma found in conjunction with a streptococcal meningitis. This simultaneous presence of an associated meningitis has not been previously reported.

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TECHNIQUES IN AIRWAY MANAGEMENT

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Syracuse, New York 13210

Techniques in airway management are displayed using anatomical models, cadaver dissection, photographs, X-rays, CT scans, and diagrams of the airway. The equipment that is used in various procedures in airway management are displayed.

This is a hands-on exhibit in which one may practice techniques on the anatomical models (cricothyroidotomy, retrograde intubation, magnetic intubation, and the insertion of the Laryngeal mask).

DETECTING ALCOHOLISM IN TRAUMA PATIENTS

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Free University Berlin, Germany

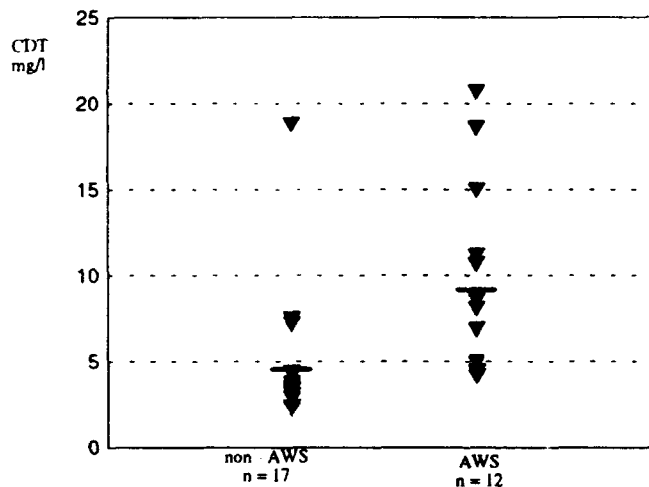
The coincidence of alcohol consumption and trauma is well documented¹. The early differential diagnosis between acute intoxication, chronic abuse and alcohol dependence is important for further therapeutic strategies to prevent alcohol withdrawal syndrome (AWS). Elevated levels of Carbohydrate Deficient Transferrin (CDT), an isoform of transferrin, are reported to be a reliable biological marker to detect chronic alcohol abuse².

In a pilot study we investigated, whether CDT could be a reliable parameter in the prediction of alcoholism associated complications as well as AWS in multi trauma patients.

Methods: 29 multiple injured patients (23 male, 6 female, median age 45, range 19 - 59 years), who were transferred to the ICU after emergency care, were included in the study. CDT was taken immediately after admission, analysis was performed by micro-anion-exchange-chromatography³. The occurrence of AWS was taken as the proof of physical dependence.

Statistical analysis was performed by the Wilcoxon signed rank sum test.

Results: 12 of the 29 patients developed AWS. The patients with AWS and those patients who did not develop AWS showed significant differences in CDT levels ($p < 0.0001$).



Tab. 1: CDT levels in trauma patients (- mean)

Conclusion: If no additional information about the patients alcoholism related history can be obtained, CDT may present a copredictor of AWS. The results await further validation.

Reference: 1. J Trauma 1986;12:1123,
2. Alcohol 1991;26:260;
3. Lab Med 1991;15:278

THE POTENTIAL FOR VENOUS AIR EMBOLISM FROM ONE LITER CRYSTALLOID BAGS.

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Introduction: In trauma situations as well as other hemodynamic emergencies, fluids are often given under pressure. This is done to overcome resistance to flow in the tubing, catheter and vein in order to accelerate the flow of fluid. During one such emergency, a bag of intravenous fluid under pressure inverted, resulting in the injection of air into the patient. Although there were no changes in vital signs, end tidal CO₂ dropped and end tidal N₂ increased. We were concerned with the quantity of air usually contained in these standard bags of crystalloid, and the potential for cumulative collection of air when several bags of solution are infused under pressure. We studied the volumes of air present in two lots of intravenous fluids at room temperature and when heated to quantify the volumes and see if heating would materially change the volume.

Methods: One liter bags of Lactated Ringers solution (Abbott Laboratories) from two different lots were tested. 25 bags at room temperature (21 C) were aspirated of air from the injecting port. This was done with a 60 cc syringe until each bag was emptied of air. There was no pressure placed upon the bag, and the syringe was drawn in a slow, even manner. If more than 60 cc of air was contained in the bag, the syringe was left at the 60 cc mark, removed, and the bag was re-aspirated until empty. No bag contained more than 120 cc of air.

An additional 25 one liter bags were placed in a warming chamber which was set at 52 C for 16 hours. The bags were aspirated of air immediately upon removal from the warming chamber. Aspiration of air was done as described above.

The values were averaged and a standard deviation was determined. The difference in means was subject to a STUDENT's t-test, two tailed, with 0.01 as the level for statistical significance.

Results: The one liter bags of crystalloid held an average of 67 cc of air with a standard deviation of 7.0 cc. No bag contained more than 85 cc of air. The one liter bags of Lactated Ringers at 52 C contained an average of 73 cc of air with a standard deviation of 7.2 cc. No bag contained more than 90 cc of air. The t value for the difference in air between the two groups was 4.18. This implies a statistically significant difference.

Discussion: Under usual operating room conditions, the packaged air in the standard one liter bags of crystalloid poses minimal threat for venous air embolism. The positive pressure in the veins prevents the crystalloid from completely draining into the patient and exposing the patient to the threat of venous air embolism.

However, under emergent conditions, it is frequently necessary to infuse fluids at a greater rate and larger quantities than what is permitted by gravity alone. Although even small quantities of air can cause catastrophic results in patients with a right-to-left shunt, large volumes of air in the venous circuit can cause significant cardiopulmonary dysfunction such as vapor lock.

Conclusion: Based on our data we conclude 1) emptying all bags of air prior to administration in emergent situations necessitating massive crystalloid administration will minimize the risk of venous air embolism.

2) warmed solutions have greater volumes of air per liter than room temperature solutions. This may have clinical significance in the small patient or in a patient who has already accumulated a critical amount of air.

Anesthetic Considerations in Diagnostic Laparoscopy for Abdominal Stab Wounds: Preliminary Observations

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Purpose of the Study:

Evaluating trauma victims who have sustained abdominal injuries remains a diagnostic dilemma. Laparoscopy has emerged as a means of assessing the abdomen.¹ This study was designed to evaluate the diagnostic accuracy of laparoscopy compared with the more traditional combination of local wound exploration and peritoneal lavage for anterior abdominal stab wounds. During the course of this study important anesthetic considerations have been identified.

Methods:

All patients who presented with stab wounds to the anterior abdomen were entered in the study. They were randomized to receive either local wound exploration with or without peritoneal lavage or diagnostic laparoscopy. Initially, diagnostic laparoscopy was performed under monitored anesthesia care (MAC) and local anesthesia (0.5% Lidocaine). The abdomen was insufflated with nitrous oxide (N₂O).

All patients received standard anesthetic monitoring. Choice of anesthetic agents and the use of invasive monitoring were left to the discretion of the anesthesia care team.

Results:

Patient characteristics and details of the procedure are shown in Table I. Of the patients entered into the study, four patients underwent diagnostic laparoscopy. One patient was uncooperative and required general anesthesia because of acute ethanol intoxication (blood alcohol level > 350 mg%). Although two patients were initially managed with MAC, both eventually required induction of general anesthesia and endotracheal intubation because of discomfort. Vital signs and pulse oximetry values remained normal throughout this period. One patient was successfully explored under minimal sedation. There were no significant complications.

Table I: Patient Characteristics

	Patient 1	Patient 2	Patient 3	Patient 4
Age	21	26	24	24
Sex	Male	Male	Male	Male
Time (min.)	80	100	55	55
ASA PS	2 E	2 E	2 E	2 E
Anesthesia Technique	Failed, MAC to GA	Failed, MAC to GA	GA	MAC

Conclusions:

The surgical procedure appears to be technically viable. However, success is dependent upon a supportive and involved trauma anesthesia team. Awake intervention mandates close observation and minimal sedation. For general anesthesia, short acting agents are most appropriate as surgical intervention is likely to be under sixty minutes. Further investigation is ongoing.

Reference: 1. J Trauma 33:101, 1992.

ANALYSIS OF ARTERIAL TO END-TIDAL CARBON DIOXIDE GRADIENTS IN VENTILATED TRAUMA PATIENTS

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We investigated the arterial/end-tidal carbon dioxide gradients in 35 ventilated trauma patients to establish if there was significant increase in the gradient in those patients sustaining blunt chest trauma. We also investigated whether or not the magnitude of the gradient was related to the severity of lung injury.

Patients between the ages of 12 and 65 requiring emergent intubation in the Trauma Resuscitation Unit as a consequence of their injuries and within four hours of those injuries, were eligible for inclusion in the study. Those patients in cardiac arrest, who were hypotensive despite treatment (mean BP < 60 mmHg), had sustained penetrating thoracic trauma or had a history of chest disease were excluded. All were intubated by a rapid sequence technique using thiopentone and succinyl choline. Sedation was maintained with titrated increments of midazolam and fentanyl with muscle relaxation achieved using vecuronium or atracurium if required. The patients were subsequently ventilated by a Servo 900C ventilator (Siemens) with a tidal volume of 10 ml/kg at a rate of 12-15 breaths per minute. Positive end expiratory pressure was not utilized unless the SpO₂ was < 92%. Clinical suspicion of chest trauma, from the initial history and examination was documented. After initial resuscitation and stabilization (including a steady ETCO₂ reading for five minutes) simultaneous measurements were taken of vital signs, ETCO₂, arterial blood gas analysis and respiratory parameters. A Lung Injury Score¹, an Injury Severity Score and a Glasgow Coma Score were calculated. The patients were followed up to determine their 24-hour APACHE 2 score, their duration of ventilation (patients ventilated for < 24 hours were excluded) and survival.

35 patients were studied, 16 of whom were classified clinically as sustaining blunt chest trauma. Of the 16 patients with chest trauma, 14 had an arterial/end-tidal carbon dioxide gradient, $P(a-ET)CO_2 > 10$ mmHg. None of the 19 patients without chest trauma had $P(a-ET)CO_2 > 8$ mmHg. The results were analysed using Chi-square and Mann-Whitney tests for non-parametric data.

The results show that patients sustaining blunt chest trauma have a significant ($p < 0.001$) increase in their arterial/end-tidal carbon dioxide gradient. There was also a positive correlation ($\rho = 0.799$) between Lung Injury Scores and the magnitude of the gradient. Furthermore, those patients with high initial gradient [$P(a-ET)CO_2 > 10$ mmHg] were ventilated for a significantly ($p < 0.02$) longer duration. We conclude that the measurement of arterial/end-tidal carbon dioxide gradient can be used to quickly identify those patients who have sustained severe lung injury, thereby allowing appropriate therapy to be instituted.

1. Am Rev Respir Dis 138:720, 1988.

BLIND ORAL INTUBATION: A SAFER ALTERNATIVE FOR AIRWAY MANAGEMENT IN PATIENTS WITH CERVICAL SPINE INJURY ?

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There is controversy concerning the most appropriate technique for the endotracheal intubation of patients with diagnosed or suspected cervical spine injury. Several authors of experimental studies reported extensive movements of the cervical spine during airway management, resulting in an increased risk for aggravating neurological damage [1]. Recently, a new device enabling blind oral intubation (Augustine Guide™) with the patients head and neck kept in the neutral position has been introduced. The aim of our study was to evaluate the extent of radioscopically viewed movements of the upper cervical spine during intubation with this device, compared to direct laryngoscopy.

Methods: After approval by the institutional ethics committee and signing informed consent, 12 patients (median age 23 yrs; Mallampati-scores I and II [2]) without a cervical spine disorder, scheduled for elective surgery, were intubated once using the Augustine Guide™ (AG) and afterwards by direct laryngoscopy (DL). Both attempts were viewed radioscopically. Extension of the upper cervical spine was measured at the point of the maximum excursion using the McGregor-line (tangential line between hard palate and the occipital bone). Data are shown as median (lower and upper quartile). Statistical analysis was done using a paired Wilcoxon-test.

Results: Intubation could be performed in either way in all patients. The median time necessary for intubation with the AG was 41 (35;50) seconds compared to 22 (15;26) seconds using DL ($P < 0.05$). Arterial oxygen saturation remained above 95% during all attempts. Oral intubation by direct laryngoscopy resulted in a significantly greater extension within all individual joints (table 1), as well as within C0-C3 taken together as a functional unit (17° , $P < 0.01$). A maximum extension of the upper cervical spine (C0-C3) of 65° was observed in one patient during direct laryngoscopy compared to 48° during blind oral intubation. Only one patient exhibited a slightly lower extension of C0-C3 during direct laryngoscopy as compared to blind oral intubation (DL: 45° vs AG: 48°).

	AG	DL	P <
C0-1	2° (-7; 9)	9° (3; 12)	0.05
C1-2	30° (29; 32)	35° (32; 39)	0.01
C2-3	-1° (-2; 4)	5° (2; 10)	0.01
C0-C3	29° (26; 39)	46° (45; 49)	0.01

C0-1 = atlanto-occipital joint

Conclusion: Blind oral intubation using the Augustine Guide™ causes significantly less extension of the upper cervical spine compared to direct laryngoscopy. Our results were obtained in patients with a stable cervical spine. Since we assume, that intubation-induced excursions of the injured spine are even higher, we recommend blind oral intubation as a safe alternative for airway management in this special group of trauma victims.

1 Aprahamian C. Ann Emerg Med 1984;13:584-87

2 Mallampati SR. Can J Anaesth 1985;32:429-34

ASYNCHRONOUS INDEPENDENT LUNG VENTILATION IN MONOLATERAL LUNG TRAUMATIC DISEASE: A CASE REPORT

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In monolateral lung trauma with severe contusion, atelectasis and low compliance, mechanical ventilation with high PEEP does not improve progressive hypoxemia why air flow is shunted to higher compliance uninjured lung with hyperinflation and hyperbarism, increasing alveolar collapse and hypoventilation of the affected lung. Independent Lung ventilation (ILV) improves acute respiratory failure increasing FRC, alveolar ventilation and compliance in pathologic lung decreasing hyperinflation and hyperbarism in uninjured lung. Moreover in asynchronous independent lung ventilation (aILV) it's possible to apply two different respiratory patterns in according to different pathophysiologic conditions of lungs.

CASE REPORT

A 49-years-old man suffered multiple injuries including severe monolateral chest trauma and pulmonary contusion after a 15 meters fall. Because of his progressive respiratory failure with dyspnea, moderate hypoxemia, and paradoxal movement of the chest, he was intubated (Mallinckrodt cuffed tube 8.5 mm.) and mechanically ventilated (Servoventilator 900 C) in Pressure Support (PSV) with PEEP 5 cm H₂O, FiO₂ 0.50. A Swan Ganz catheter was positioned. After 24 hours a chest x ray film and a computed tomographic scanning showed a large contusion interesting more than half right lung and development of ARDS with interstitial and alveolar edema; moreover decreased lung compliance resulting in a loss of FRC, intrapulmonary shunt and oxygen refractory hypoxemia; hyperinflation in left lung and mediastinal shift (fig. 1). Notwithstanding CPPV with supplemental PEEP 10 cm H₂O, alveolar collapse, hypoventilation and hypoxemia (PaO₂ < 50 mmHg) increased. We decided to apply ILV by using a double lumen tube (Rush 39 F) with two different respiratory patterns in according to the different pathophysiologic situation of lungs:

Right lung: CPPV, PEEP_i 18 cmH₂O, PEEP 15 cmH₂O, FiO₂ 0.50, TV 300 ml

Breathing 10 per m.

Left lung: CPPV, PEEP_i 0 cmH₂O PEEP 2 cmH₂O, FiO₂ 0.30, TV 500 ml

Breathing 15 per m.

DISCUSSION

In this case ILV decreases intrapulmonary shunt (Q_{sp}/Q_t) reducing hyperinflation in uninjured lung (hyperinflation compress pulmonary vessels so that haematic flow is shunted to hypoventilated lung), increasing alveolar ventilation, compliance and FRC in pathologic lung. Air flow is no more shunted to hyperventilation lung but equally distributed in according to T.V. of the two ventilators. After 24 hours of aILV PaO₂ increased over 100 mmHg PEEP_i decreased to 8 cmH₂O (fig. 2). During asynchronous ventilation no haemodynamic change was noted.

CLINICAL SIDE EFFECTS OF A RAPID INFUSION OF 7.5 % HYPERTONIC SALINE IN CONSCIOUS PATIENTS.

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The use of hypertonic solutions is effective in restoring adequate hemodynamic conditions in the prehospital management of traumatic hypotension (1). Secondary effects of a "bolus" administration of a hypertonic saline solution are most often kept in the background of clinical studies. The aim of this preliminary study was to evaluate the clinical adverse effects of a rapid infusion of 7.5% hypertonic saline (HSS) in conscious patients before a vascular surgery.

Patients and Methods :

After institutional approval and informed consent, 13 patients were divided preoperatively into 2 groups according to an open, random sequence in order to restore stable cardiocirculatory conditions : 1) HSS was administered before induction of anesthesia and after the placement of an invasive hemodynamic monitoring (HSS patients, n=8) ; 2) a standard 6.0% HES-200 was administered in "control" patients (HES patients, n=5). Adverse effects which were noticed during the infusion, were compared in each group.

Results :

Age, Sex (all males), ASA score, pre- Infusion and pre- Anesthesia induction hemodynamic parameters were comparable in the 2 groups.

	HSS	HES
Age	63±6	63±3
ASA score	2-3	2-3
Infusion Volume	240±70	900±200
Infusion Flow (ml/mn)	40-50	50
Transient Hypotension	2/8	0/5
Cutaneous Vasoconstriction	4/8	0/5
Confusion, Agitation	2/8	0/5
Thirst	6/8	0/5
Sensation of Warmth	6/8	0/5
Pain at the site of injection (peripheral) *	2/2	0/5
Pain at the site of injection (central)	0/8	---

*The acute pain at the site of injection (initially : peripheral vein access) necessitated the administration of HSS through a central venous line in all the following HSS patients.

Conclusion :

In this preliminary report, a rapid administration of hypertonic saline is accompanied by a number of side effects. A central venous access seems to be a better condition in conscious patients. Agitation, discomfort, and transient, brief hypotension should be known before a larger/"routine" use.

This Study was supported by Assistance Publique / Hôpitaux de Paris.

References :

(1) Mattox KL et al . Prehospital hypertonic saline/ Dextran infusion for post-traumatic hypotension. The USA multicenter trial. 1991 Ann Surg : 213,5 :482-91

ACUTE NEUROLOGIC INJURY: CARDIOVASCULAR RESPONSE TO EMERGENCY INTUBATION

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The cardiovascular response following central nervous system injury is characterized by a hyperdynamic state secondary to marked elevations in serum catecholamines.¹ This condition is often exacerbated with laryngoscopy and intubation resulting in significant tachycardia and hypertension despite the judicious use of inhalational agents, sedative-hypnotics, narcotics and lidocaine to blunt such a response. Emergency intubation in this population can be fraught with potentially deleterious hemodynamic changes, yet little data exists documenting the incidence.

177 adult patients (age 18-93yrs) who required emergency intubation related to CNS injury were prospectively evaluated over a two year period. The intubator complete a questionnaire following the procedure and a follow-up evaluation was performed by the author (TM) upon stabilization in the ICU. Disease categories included isolated closed head injury (CHI) (50pts), stroke and intracranial bleed (108pts) and epileptic seizure disorder (19pts).

Definitions of hemodynamic alteration: hypertension; $\uparrow > 20\%$ of MAP if SBP $> 150\text{mmHg}$, hypotension; $\downarrow > 20\%$ MAP if $< 65\text{mmHg}$, tachycardia; $\uparrow > 20\%$ if HR is > 100 beats/min and bradycardia; < 60 beats/min if $> 20\%$ decrease from baseline. Data analysis by chi-square, Student's t-test and ANOVA methods was performed.

A hypertensive response to intubation was the most common hemodynamic alteration (81/177, 46%). The category of CHI had a profound incidence of hypertension (40/50, 80%), most likely relating to the youthful mean age (35yrs) and CNS injury state. Both age and pre-existing history of hypertension correlated inversely with the incidence of hypertensive response. ($< 30\text{yrs}$, 69% vs $> 70\text{yrs}$, 36%, $p < .01$) Hypotension was a much less frequent response to laryngoscopy and intubation (30/177, 17%) and age was not a predictive factor. Isotonic crystalloid infusion (500cc) reversed the hypotensive response in 20/30 patients, yet, despite volume loading, the remaining 10 patients required vasopressors to raise the MAP above 65mmHg. A tachycardic response was common (76/177, 43%) and, again, was inversely correlated with age ($< 30\text{yrs}$, 53% vs $> 70\text{yrs}$, 38%, $p < .01$). Bradycardia was infrequent (8/117, 5%) but correlated with episodes of hypoxia (6/8) and regurgitation (4/8). ICP monitoring revealed that 7 of 8 patients experienced marked elevations in ICP of 40%-550% above baseline during and immediately after laryngoscopy and intubation. Equally, tachycardia and hypertension occurred in this group despite aggressive preparation with pentothal (3-5 mg/kg) with adjunct intravenous lidocaine, benzodiazepines, and narcotics.

In conclusion, the underlying catecholamine induced hyperdynamic state which accompanies acute CNS injury is managed, at best, with difficulty in a controlled OR environment. This data collection illustrates the significant incidence of hypertension and tachycardia that may typify the emergency airway intervention in this population. An aggressive induction technique and the use of appropriate anti-hypertensives should be considered when confronted with CNS injury, especially in the subgroup of isolated closed head injury.

1) Journal of Neurosurgery 59:447, 1983

COMPLICATIONS OF RE-INTUBATION FOLLOWING SELF-EXTUBATION

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Our experience with airway management following self-extubation in the ICU environment has presented several instances of patient morbidity and mortality. This in contrast to a recent review that suggested minimal to no potential sequelae¹ with reintubation following self-extubation. Airway management in our institution is handled by a combination of anesthesia residents and critical care personnel working within the ICU assisted by 24 hour anesthesia backup.

A prospective review of 937 non-code intubations over a two year period identified 47 patients who self-extubated and required reintubation within 30 minutes. Patient were located in surgical, medical or neuro ICU settings and consisted of cardio-pulmonary, trauma, septic and neurologic populations ranging in age from 18-95 years old. Hemodynamic definitions: hypertension $\uparrow > 20\%$ MAP if SBP $> 150\text{mmHg}$, hypotension; $\downarrow 20\%$ MAP if $< 65\text{mmHg}$, tachycardia; $> 20\%$ if 100 beat/min and bradycardia; $\downarrow 20\%$ if < 60 beats/min.

Overall, only 14 of 47 patients (30%) experienced no hemodynamic or airway related complications following emergency reintubation. 16 patients (34%) developed intubation induced tachycardia and 2 patients had presumed hypoxemia induced bradycardia. 6 patients (13%) had a sustained hypertensive response following intubation and 19/47 (40%) developed hypotension (MAP < 65 mmHg). Despite volume resuscitation of 500cc isotonic crystalloid, 6 patients required vasopressors to return the MAP $> 65\text{mmHg}$. 8 episodes of hypoxemia ($\text{O}_2\text{SAT} < 85\%$) during intubation took place. 7 esophageal intubations led to 6 of the 8 hypoxic episodes. Difficulty obtaining airway control (≥ 3 attempts) occurred in 7 patients and 5 of the 7 were associated with hypoxemia. One airway was unattainable leading to hypoxemia, cardiac arrest and death. Moreover, 2 main stem intubations were recognized (delayed), 2 episodes of bronchospasm, 2 episodes of \uparrow ICP, as well as, 2 accidental self-extubation following reintubation were noted.

In contradiction to a previous report on the minimal sequelae of reintubation, our experience suggests a profound incidence of both hemodynamic and airway related complications (70%) in our patient population. Therefore, airway control following self extubation in the critically ill ICU population can be fraught with complications leading to significant morbidity and even mortality. The availability of anesthesia services on an emergency basis would appear to be imperative to handle such critical airway management decisions and procedures.

DIAGNOSIS OF THORACIC SPINE INJURY IN CHEST TRAUMA.

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In blunt thoracic trauma, thoracic spine injuries are frequently associated (25%). Neurosurgical treatment of these lesions is, generally, considered after cardiorespiratory resuscitation, secondary transport to neurosurgical ICU, and evaluation of associated life threatening conditions. A prospective study examined all patients recovered during 1992 in our ICU, with blunt thoracic trauma. Thirty-six multiple trauma patients entered in this protocol. We had evaluated by a thoracic CT scan the incidence of thoracic spine injuries in chest trauma. All patients presented chest trauma complicated by respiratory failure (98%), needing mechanical ventilation (88%), and mono (42%) or bilateral (15%) pleural drainage by pneumothorax, posttraumatic coma (3%), shock (78%), hemoperitoneum (10%), paraplegia (10%). CT scan of thorax was performed after respiratory and hemodynamic stabilization. CT scan of brain and cervical tract was performed when a patient was comatose with a history of loss of consciousness or motor function. The majority of spine fractures was secondary to motor vehicle accidents or sports. The common associated lesions were head (25%), long bones (33%), abdominal (12%). In 3 patients CT scan was decisive in defining thoracic spine fractures, suspected in 2 patients presented neurologic deficit (paraplegia). In one patient, whereas, it was not possible to evaluate neural damage because he was comatose. The thoracic spine (T1/T10) is stabilized by the ribs and it is subjected to its own form of injuries; it is also well protected, strongly reinforced by the ligaments and required high forces to produce fracture. In literature, 82% of thoracic spine injuries had accompanying associated injuries reflects anatomic stability offered by rib articulation. While not statistically significant one third of thoracic fractures had associated chest trauma. With multiple rib fractures and dislocations, thoracic spine stability will be compromised, moreover, medullary canal and medulla have almost the same diameter. Consequently, a small dislocation produces a medullary compression and ischemia, because there are terminal arteries. CT scan of thorax shows higher sensitivity than x-ray examination in focusing traumatic lesions of chest and spine. In our patient CT scan, always, supplied useful and important data, without increase of patients' mobilization and permitted to fix carefully the therapeutic and surgical priorities. In fact, CT scan shows all liquid or gaseous pleural effusion and parenchymal, even small, contusions. However, we think x-ray of thorax is the first examination, after admission to hospital, when it is not possible to perform fast CT scan, which should always be performed because the stabilization of the injured spine allows easier nursing, prompt mobilization and earlier rehabilitation.

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- 2) Saboe L.A., Reid D.C., Davis L.A. et al.: Spine trauma and associated injuries. J. Trauma 31, 43, 1991

Title: CHANGES IN ARTERIAL END-TIDAL PCO_2 DIFFERENCE AND PHYSIOLOGICAL DEADSPACE DURING HEMODYNAMIC ALTERATIONS

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The abnormalities in the ventilation and perfusion relationship (V/Q) may occur in patients undergoing surgery associated with hemodynamic alterations. Previously, substantial variations of arterial end-tidal PCO_2 difference (Pa-ETCO_2) were observed in patients undergoing cardiac or major vascular surgery but factors contributing to Pa-ETCO_2 were not identified. This study examines the patterns of the changes in Pa-ETCO_2 and physiological deadspace (VD/VT) and their relationship to the hemodynamic changes associated with abdominal aortic cross-clamping (AX) and declamping (DX).

Thirteen patients with COPD and eleven patients without COPD who underwent abdominal aortic aneurysm surgery were studied with the IRB approval. Monitoring included end-tidal PCO_2 (PETCO_2), mixed expired air PCO_2 (PECO_2), arterial blood gases and cardiac output (hemodilution). Ventilation was maintained constant during the study period. Hemodynamic and arterial blood gases measurements were performed 5 minutes prior to AX (Stage 1), 10 minutes after AX (Stage 2), and 10 minutes after DX (Stage 3) and the results are shown in Table 1.

(1) In patients with COPD, VD/VT and Pa-ETCO_2 were significantly greater compared to the patients without COPD in each stage. (2) In both groups of patients following AX, cardiac index (CI) and PETCO_2 decreased and VD/VT increased. Changes in Pa-ETCO_2 were not significant. (3) Following DX, PETCO_2 and CI increased, and VD/VT decreased significantly. Changes in Pa-ETCO_2 were not significant. (4) The ratio of $\text{PECO}_2/\text{PETCO}_2$ was approximately 0.7 and did not change by AX and DX. Accordingly, the theoretical relation between Pa-ETCO_2 and VD/VT could be derived from the alveolar equation and can be expressed as: $\text{Pa-ETCO}_2 = \text{PaCO}_2 \times (1.43 \text{ VD/VT} - 0.43)$ (Fig. 1). Following AX, the effect of the increase in VD/VT on Pa-ETCO_2 was counterbalanced by the decrease in PaCO_2 that occurred secondary to the decrease in CO. Following DX, the effect of the decrease in VD/VT on Pa-ETCO_2 was also counterbalanced by the increase in PaCO_2 . Thus, the changes in PaETCO_2 could be understood only when one considered the simultaneous changes in VD/VT and PaCO_2 associated with the changes in CO. Table 1.

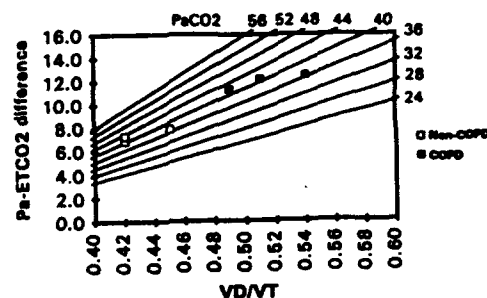
Fig. 1

Parameter	Group	Stage 1	Stage 2	Stage 3
VD/VT	Non-COPD	0.42 ± 0.04	0.45 ± 0.05 Δ	0.42 ± 0.06 #
	COPD	0.51 ± 0.07 ¶	0.54 ± 0.07 Δ¶	0.49 ± 0.06 Δ¶#
Pa-ETCO ₂	Non-COPD	6.9 ± 1.8	7.9 ± 2.2	7.3 ± 2.6
	COPD	12.2 ± 3.0 ¶	12.5 ± 3.1 ¶	11.3 ± 3.8 ¶
PETCO ₂	Non-COPD	28.1 ± 3.6	25.6 ± 3.1 Δ	33.3 ± 6.2 Δ#
	COPD	29.7 ± 2.6	25.7 ± 2.4 Δ	33.0 ± 8.0 #
PECO ₂ /PETCO ₂	Non-COPD	0.72 ± 0.05	0.71 ± 0.05	0.70 ± 0.05
	COPD	0.69 ± 0.07	0.68 ± 0.06	0.69 ± 0.05
CI	Non-COPD	2.51 ± 0.50	2.16 ± 0.41 Δ	3.40 ± 1.15 Δ#
	COPD	2.59 ± 0.99	1.86 ± 0.67 Δ	3.31 ± 1.39 #

Δ: P<0.05 as compared to stage 1

¶: P<0.05 as compared to non-COPD

#: P<0.05 as compared to stage 2



PREVENTABLE DEATHS IN VICTIMS OF MAJOR TRAUMA

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A twelve month audit of the epidemiology of Major Trauma (ISS>15) identified 1088 patients in 16 hospitals serving a population of 3.2 million. 430 patients died at scene, 309 died in hospital and 349 survived.

Types of injury were: blunt 76%, penetrating 3.6%, burns 5.8%, drowning 4.6%, hanging 7.5%, asphyxia 1.4% and electrocution 0.7%.

By TRISS methodology, unexpected outcomes occurred in 134 (24%) of 554 admitted blunt trauma patients, 125 unexpected deaths (53%) and 9 unexpected survivors (2.8%). The rate of unexpected death varied from 33% to 70% between hospitals.

309 admitted patients died, 46 (15%) of the deaths were assessed as being preventable. 44 preventable deaths occurred in blunt trauma patients (16% of blunt trauma deaths); 1 death from penetrating trauma (17%) and 1 death from drowning (17%). The preventable death rate for blunt trauma varied from 0% to 26% between hospitals.

In patients sustaining blunt injuries, 13% of head injury deaths and 22% of non-head injury deaths were preventable. In all preventable head injury deaths, either delay in operation (35%) or no operation for mass lesions (65%) occurred. Misdiagnosis (39% overall) as drunkenness (22%) or CVA (26%) was common.

Multiple preventable factors were more likely in non-head injury deaths which were preventable. These included : missed injury (67% - chest 43%, abdomen 33%) poor airway care (57%), delayed or no operation (53%), inadequate surgery (19%) and under-transfusion (38%). Three (8.1%) of 37 preventable blunt trauma deaths had probabilities of survival less than 50% (2%, 35% and 48%) by TRISS methodology and were not therefore identified as unexpected, whereas 73% of unexpected deaths were not considered preventable on expert clinical review.

PEDESTRIAN ACCIDENTS, INJURIES AND CARE IN NORTH WEST BRITAIN

DN Teanby, DF Gorman, DA Boot

Warrington General Hospital, Warrington, Cheshire, Great Britain

160 serious pedestrian accidents (ISS>15 or Death), were identified during a 12 month prospective study of all trauma in a population of 3.2 million. 35 died at scene, 125 arrived at hospital alive and 68 (54%) subsequently died. 35 (22%) were children and 62 (39%) aged greater than 60 years. Median ISS values were similar between the age groups. RTS and APACHE II showed significant differences between those that lived and died. TRISS analysis revealed that 32 per cent of deaths and 12 per cent of survivors were unexpected.

Head injuries were more severe and common in children, whilst chest injuries were more common in adults and the fatally injured elderly. Abdominal injury was rare.

Ambulance prehospital care was inadequate, with only small volumes of IV fluid given and less than half of the unconscious patients had a cervical collar applied. Pre hospital care significantly delayed transit to hospital.

In Accident and Emergency only 38 per cent of those unconscious had a cervical collar applied, and 66 per cent were intubated. Of those transferred for neurosurgical care 33 per cent were not intubated.

Analysis of police accident statistics showed that 17 per cent of these cases had not been recorded. 90 per cent of accidents were due to pedestrian behaviour, only 34 per cent of involved drivers were breath tested. Elevated blood alcohol among victims was uncommon.

Children with Head or Multiple Injuries and the elderly with Chest Injury are most at risk following pedestrian Accidents. ATLS treatment protocols should be instituted in all A+E Departments.

Changes in vehicle design, Public education or physical separation of cars and pedestrians may reduce the frequency and severity of accidents.

AUDIT OF MULTIPLY INJURED PATIENTS IN NORTH WEST BRITAIN

DN Teanby, DF Gorman, M Sinha, DA Boot.

Warrington General Hospital, Warrington, Cheshire,
Great Britain.

The care of the injured in Great Britain has been regarded as unsatisfactory by several authors. To enable constructive improvements in Trauma Care a broad study of patient characteristics and workload is required.

A one year prospective audit of 1088 victims of severe trauma presenting to 4 Teaching and 12 District General Hospitals, serving a population of 3.2 million, in Mersey Region, North Wales and the Isle of Man was carried out. Severe trauma was defined as, Injury Severity Score (ISS) greater than 15 or Death due to Trauma (excluding elderly fracture neck of Femur).

Four Hundred and Thirty patients died prior to arrival at hospital, 658 patients arrived alive and 309 (47 per cent) of these subsequently died.

Mechanisms of injury were, Blunt 76%, Penetrating 3.6%, Burns 5.8%, Drowning 4.6%, Hanging 7.5%, Asphyxia 1.4% and Electrocution 0.7%. The incidence of penetrating injury was markedly lower than in the U.S.A..

8.2% of blunt trauma casualties were children and 24% were aged greater than 65 years, with a general male preponderance of 2.6 to 1.

Road accidents were the cause of injury in 66%, and falls in 24%. Pedestrian injuries were more common in children and the elderly. Vehicle drivers and motor cyclists were predominantly young adult males.

17% were injured at home usually due to falls. This group was mainly female and older. 5% were injured in work accidents, mainly by falls from height or crushed by weights or machinery.

Blunt trauma patients who died were older (40.6 Yrs. BID, 52.4 Yrs. Died In Hospital, 34.4 Yrs. Lived), more severely injured (ISS, 66 BID, 36 D, 25 L), and in a worse physiological condition on arrival at Hospital (RTS 4.8 D, 6.6 L, APACHE II 22.8 D, 11.8 L, $p < 0.05$)

These patients accounted for only 0.08% of Accident Department workload, with 3.1 new patients per hospital per month. (Range 1 - 5 patients)

In-hospital mortality for blunt trauma was 45% and analysis using TRISS methodology indicated that 47% of deaths and 6% of survivors were unexpected.

Peer review suggested that 16% of in-hospital deaths (28 male, 16 female) (13% of Head Injury deaths, 22% of non-Head Injury deaths) may have been preventable.

A REVIEW OF PAEDIATRIC TRAUMA IN NORTH WEST BRITAIN

DN Teanby, DA Lloyd, DF Gorman, DA Boot

The Royal Liverpool Children's Hospital, Liverpool and
Warrington General Hospital, Warrington, Cheshire, Great Britain

The purpose of this study was to review the management and outcome of 102 severely injured children (Injury Severity Scores (ISS) >15 or death) recorded during a one year audit of all severe trauma in an NHS Region with a population of 3.2 million. Their mean age was 8.2 years (range 3 mo.-15 yrs.) and 62% were male. The causes were blunt injury in 75 (73.5%) burns - 11, drowning - 11, hanging - 3, electrocution - 1, and asphyxia -1. There was no case of penetrating trauma.

Paediatric trauma (all causes) made up only 0.007% of Accident Department workload, with each District General Hospital (DGH) receiving only 3.9 children per year (cf. adult severe trauma 37 patients /hospital /year). Comparison between DGH's and Children's Hospital (CH) showed no differences in age, sex, injury mechanism or ISS. Management errors were made in DGH's and CH. I.V. access was by single cannula in 75% patients, airway care by intubation in 45% and cervical collars were used in only 30%. Significant injury was missed in 24%, 10% were under transfused, airway care was deficient in 28% and surgery was delayed in 20%. Statistical significance was reached only for airway care and pre-operative delay where the CH was better.

The blunt injuries were analyzed in detail. 52 (70%) were injured on the roads, 38 as pedestrians.

Distribution of injuries:	Head	Chest	Abdomen
Pre-hospital deaths (n=15)	100%	67%	13%
Admissions (n=60)	85%	16%	22%
In-hospital deaths (n=23)	91%	59%	35%

21 patients with head injury were transferred to the regional Neuro-Surgical Centre. Median ISS were significantly different between survivors and fatalities (25 and 45) but not different between pre- and in-hospital deaths.

TRISS analysis indicated 5 unexpected deaths; In 4, significant injury was missed and airway care was deficient.

There is a need to improve paediatric trauma management at both tertiary care level and at District General Hospitals by developing trauma management protocols.

The low numbers of severely injured children presenting to DGH's suggests a need for a regional trauma system with centralisation of care.

CLINICAL TOLERANCE OF HIGH DOSES OF HYDROXOCOBALAMIN (HOCO) IN FIRE CYANIDE POISONING VICTIMS

C. Favier,^{*,†} F. Baud,[†] F. Richter,[‡] M. Imbert,[‡] H. Julien,[‡]

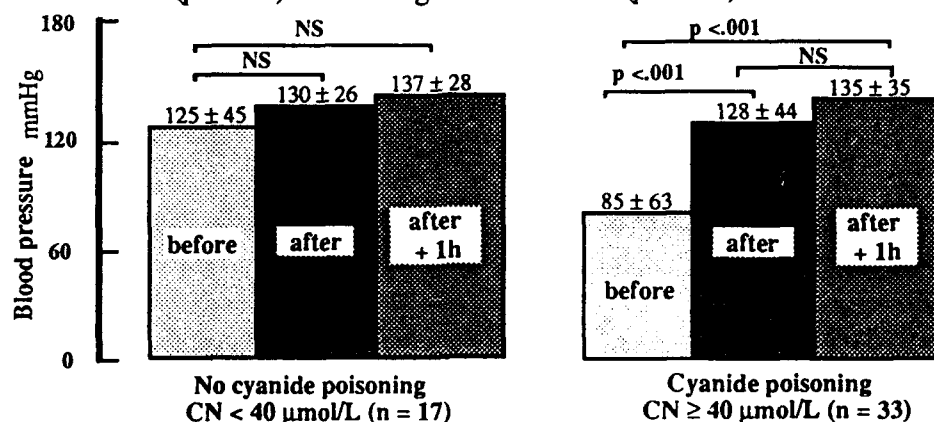
Département d'Anesthésie-Réanimation, Université de Nice Sophia-Antipolis, Hôpital St Roch, F-06000 Nice. [†] Réanimation Toxicologique, Hôpital F Widal, Paris. [‡] Brigade de Sapeurs Pompiers de Paris.

INTRODUCTION: Cyanide (CN) poisoning in fire victims is frequent, with a high rate of pre-hospital mortality. An antidotal treatment could be administered on the scene of the fire. We have used hydroxocobalamin as an antidote whose action appears to be rapid and efficient and because, in comparison with nitrites and cobalt edetate, it appears to have low toxicity.

AIM: To study was to evaluate the clinical tolerance of high doses of HOCO administered to victims of residential fires.

METHODS: This prospective study included 50 fire victims. Criteria of inclusion: Presence of soot in the mouth or in the expectoration, accompanied by disturbed consciousness (coma, lack of consciousness even temporary) or disorders of higher functions (confusion, slowness of reaction). Criteria for exclusion: children, pregnant women, cutaneous burns > 20% of the body surface, polytraumas. After clinical examination and the taking of blood samples, 5g of HOCO (10g in the case of cardio-respiratory arrest) were administered in 15 minutes. Systolic arterial blood pressure was measured on arrival at the victim's side, after administration of the antidote, and one hour later. Any allergic reactions were noted. Results are expressed as mean \pm SD. Statistical significance ($p < .05$) was determined using non parametric tests.

RESULTS: The mean age of the victims (28 women and 22 men) was 54 ± 20 years, the mean blood cyanide concentration was 83 ± 73 $\mu\text{mol/L}$ and the mean carbon monoxide concentration was 3.2 ± 2.1 mmol/L . Among the 19 victims who died, 12 were found dead at the scene of the fire. No allergic reaction was observed. Among the 17 non-intoxicated patients ($\text{CN} < 40$ $\mu\text{mol/L}$) we noted no change in arterial blood pressure. In 33 intoxicated patients ($\text{CN} \geq 40$ $\mu\text{mol/L}$) a significant increase in blood pressure was observed after administration of HOCO ($p < .001$) continuing one hour later ($p < .001$).



CONCLUSION: Hydroxocobalamin given in high doses to victims of domestic fire accidents is well tolerated, and can be proposed as an antidote to cyanide poisoning during the pre-hospital stage.

PHENOMENON OF ERYTHROCYTES REDISTRIBUTION OF DIFFERENT AGED FRACTIONS AND ITS ROLE IN THE CORRECTION OF EXTERNAL CONDITIONS

Banas U.K., Korobov V.N., Gorbai A.V.

Department of anesthesiology, Medical Institute, Lvov, Ukraine.

The purpose of this work was the study of the age changes dynamics of peripheral venous blood erythrocytes in:

- 1/ anesthesia conditions;
- 2/ extracorporeal blood circulation and intensive therapy in 62 patients.

Anaesthesia introduction was conducted by barbiturates. Anaesthesia here means neuroleptanalgesia(NLA-2).

Erythrocytes divided into 7 fractions(1+2 - senile, 3+5- middleaged and 6+7- new aged) in saccharose gradient of density. Simultaneously we studied some ratios of: K+/Na+, GSSG/GSSH, L.A./P.A., 2+3-DPG, Pi, pH, sugar; as well as aggregation degree deformation, average volume and rate of erythrocytes sedimentation. Researches were conducted with the study of different functional conditions of the central nervous system(anesthesia induction, consciousnessrecovery), before and after extracorporeal blood circulation(heparin introduction and blood coagulability recovery), hemodynamical instability (volume of the ischemia load and catecholamines application), temperature rate, acid-basic condition parameters & electrolytic displacement in blood, as well as during the 1st, 3rd, 6th & 12th days of a postoperation period.

The test group was formed from 12 donors & 20 patients (who were operated on a heart using the covered methods(mitral commissurotomy)).

Such results were obtained:

- in patients with a mitral commissurotomy at the end of the operation we observed erythrocytes quantity increasing of the senile- & middleaged-, but immediately after the contact on the muscular rigor background & temperature increasing of erythrocytes quantity of the new age;
- after heparin neutralization by protaminesulfate solutions & giving of calcium chloride, the increasing of quantity of new aged erythrocytes were observed;
- when Ca hypothermia temperature increasing, there were the quantity increasing of new- & middle aged erythrocytes, but when some decreasing of Ca hypothermia background temperature, there were quantity increasing of middle aged erythrocytes & quantity decreasing of senile aged ones.

When applying of cardiac glycosides & glutamine acid, there is a displacement to some increasing of senile aged cells content in blood.

So, the revealed phenomenon of erythrocytes redistribution in age fractions with mobile constallations formation determined by functional condition of patients & by intensive therapy ingredients is ought to use for the creation of the definite background condition of organism cells with the purpose of their optimum survival in such extremal conditions.

- REFERENCES: 1. 10th WCA, the Hague, the Netherlands;
June 12+19, 1992, p.45.
2. 10th WCA, the Hague, the Netherlands;
June 12+19, 1992, p.46.

SIMULTANEOUS SESSION V.

Special CRNA Session: Part I

This special session for CRNAs (as well as interested physician anesthesiologists) has been developed by CRNAs who are actively involved in the MIEMSS and other outstanding trauma centers to address major issues in providing critical care anesthesia skills for seriously injured trauma patients. The topics addressed will give practical information on resuscitation, stabilization, and appropriate anesthesia care delivery to complement the main symposium program material. While the main symposium program will provide a comprehensive conceptual framework, this session emphasizes the practical skills needed in the care of trauma patients.

Moderator: Charles R. Barton, CRNA, MEd

Initial Assessment of the Trauma Patient

Christopher Romanowski, CRNA

Lessons Learned in Trauma Anesthesia

John Connelly, CRNA

Mechanisms of Injury in Trauma

Cynthia Roy, CRNA, BSN

Anesthetic Management of the Spinal Cord Injured Patient

Charles R. Barton, CRNA, MEd

Use of Fiberoptics in Airway Management

Delores A. Donnelly, CRNA, BS

Panel Discussion

INITIAL ASSESSMENT OF THE TRAUMA PATIENT

Christopher Romanowski, CRNA

I. Introduction and ATLS Standards

A. Primary Survey and Resuscitation

B. Secondary Survey and Definitive Management

II. Primary Survey (ABC's)

A. Airway

1. Assessment, Anatomy, Dentition, Obstruction

2. Initial Interventions: Equipment, Drugs, Techniques

3. Cervical Spine, Anatomy, Immobilization Techniques

B. Breathing

1. Ventilatory Status, Inspection, Palpation, Percussion, Auscultation

2. Immediate Threats, Tension/Open Pneumothorax, Flail Chest

C. Circulation

1. Rapid Control of External Bleeding

2. Causes of Cardiac Pump Failure: Cardiac Arrest, Tension Pneumothorax, Cardiac Tamponade, Myocardial Contusion/Infarction, Coronary Air Embolism

3. Volume: Assessment, Access, Fluids, Monitoring

D. Disability

1. Baseline Neuro Exam, AVPU Method

E. Exposure

1. Total Body Exposure: Cutting/Shearing of Clothing,
Minimal Body Movement, Maintaining Patient
Integrity

III. Patient History

- A. AMPLE Method
- B. Review of "Hands On" Pearls That Have Proven Efficacy in
Anesthesia/Critical Care Management of Trauma Patients

LESSONS LEARNED IN TRAUMA ANESTHESIA

John Connelly, CRNA

I. Following the Rules

- A. The ABC's**
- B. ATLS Protocols**

II. Anesthesia Care Imperatives

- A. From Admission to Post-Op**
- B. Role of the Anesthetist From Consultant to Team Leader**

III. Difficult Airway Problem Solving

- A. Severe Maxillofacial Trauma**
- B. The Prone Patient**
- C. Nasotracheal Intubation in Perspective**
- D. Recognizing Evolving Injuries**
- E. Surgical Airways: Emergent and Elective**

IV. Hemorrhagic Shock

- A. The Obvious and Not-So-Obvious**
- B. Vascular Access**
- C. Rapid Infusion Devices**
- D. Inotropic Support**

V. Central Nervous System Injuries

- A. Spinal Cord Injuries**

B. Closed Head Injuries

VI Exposure

A. Injury Identification

B. Early Treatment and Prevention of Hypothermia

VII. Volume Resuscitation

A. Replacing Greater than One Complete Blood Volume

B. Crystalloids, Colloids and Blood Products

VIII. Organizational Skills

A. Team Versus Single Provider Care

B. Standardizing Procedures and Care

IX. Universal Precautions

A. The Current Infectious Disease Data

B. Common Sense Practice that is Not-So-Common

MECHANISMS OF INJURY IN TRAUMA

Cynthia Roy, CRNA, BSN

I. Introduction and History

II. Various Types of Trauma

A. Penetrating

1. Sub-Types

B. Blunt

1. Sub-Types

C. Mixed and Others

III. Physics of Traumatic Injuries

A. High Velocity vs. Low Velocity

B. Kinetic Energy

IV. Injuries to Specific Structures

A. Neck

B. CNS

C. Thoracic Cavity

D. Abdomen

E. Extremities

V. Types of MVA Injuries

VI. Other Mechanisms of Injuries

- A. Falls
- B. Smoke Inhalation
- C. Nuclear, Biological, Chemical, Environmental

**ANESTHETIC MANAGEMENT OF THE PATIENT WITH ACUTE SPINAL CORD
TRAUMA**

Charles R. Barton, CRNA, M.Ed.

I. Introduction

- A. Demographics of Spinal Cord Injuries**
- B. Mechanisms of Injury**

II. Initial Evaluation and Management of the Suspected Spinal Cord Injured Patient

- A. Correlation with the Six "P's": Paralysis, Pain, Position, Parathesias, Ptosis, and Priapism**
- B. Neurological Examination and Documentation**

III. Airway Management

- A. Evaluation on Cervical Spine - Radiographics, Lab, ABG, SpO2**
- B. Stable Versus Acute Respiratory Distress**
- C. Nasal Versus Oral Intubation**
- D. Management of Emergent Patient**

IV. Spinal Shock

- A. Clinical Presentation**
- B. Spinal Versus Hemorrhagic Shock**
- C. Treatment**

V. Anesthetic Management

A. General, Regional

B. Drugs and Techniques

C. Neonatal Resuscitation

FIBEROPTIC INTUBATION

Dee Donnelly, CRNA

I. Introduction

II. Indications and Contraindications to use of Fiberoptic Intubation

III. Types of Approach

- A. Oral Route**
- B. Nasal Route**

IV. Preparation of the Patient

- A. Preoperative Assessment**
- B. Drugs and Equipment**

IV. Procedure

- A. Oxygenation**
- B. Monitoring**
- C. Local Blocks**
 - 1. Superior Laryngeal Nerve Blocks**
 - 2. Transtracheal Block**
 - 3. Transtracheal Topical Spray**
 - 4. Application of Topical Cocaine**
 - 5. Direct Topical Sprays to Oral Pharynx, Nares**
 - 6. Topical Spray via the Fiberoptic Instrument**

D. Technique

- 1. Nasal Dilation**
- 2. Endotracheal Intubation with Fiberoptics**
- 3. Verification of Placement**
- 4. Securing of ETT and Induction of General Anesthesia**

VI. Special Considerations

- A. C-Spine Status**
- B. Intermaxillary Fixation**

VII. Summary and Conclusions

SIMULTANEOUS SESSION VI.

Trauma Anesthesia Research: Scientific Free Papers: Part I

During this session participants will give brief oral presentations using slides of scientific material related to trauma anesthesia and critical care. An award will be given for the best presentation. Presentations will be chosen on the basis of scientific merit and content.

Moderator-in-Chief: Enrico M. Camporesi, MD

*Moderators: Pierre A. Carli, MD
Levon M. Capan, MD
Bruce F. Cullen, MD
Adolph H. Giesecke, MD
Colin F. Mackenzie, MD
Ronald G. Pearl, MD, PhD*

SCIENTIFIC FREE PAPERS: PART I

Friday, May 21, 1993

Effects of Postoperative Autotransfusion in Spine Surgery

Fiberoptic Bronchoscopy in Brain Dead Organ Donors

Prehospital Monitoring of Body Temperature in Trauma Patients

Prehospital Management of Trauma Resulting from Entrapment

Effects of Various Dialysates on the Removal of Theophylline Using CAVHD

Dose-Response Study of Oxygen Transport and Hemodynamic Effects of Milrinone in Critically-Ill Patients

Diaphragmatic Performance in Ventilated Ewes

The Laryngeal Mask Airway: First Clinical Experience in Alexandria University Hospitals

Method of Correction of Life Cycle of Celis in Patients at Critical Conditions

Effects of Body Positioning in Patients with ARDS Following Multiple Trauma

Oxygen Delivery Characteristics of the Hudson Mask with Reservoir Bag

Introduction of a Rescue Helicopter Service in Kenya Experiences from a Workshop at Nairobi

Perioperative Management of Severe Trauma Patients

Determination of Vecuronium Requirements in the Thermally Injured Patient

Airway Related Complications of Emergency Intubation

Prehospital Management of Elderly Trauma Patients

Guidelines and New Techniques: An Intellectual Challenge

Rapid Resuscitation May Contribute to Hypothermia Despite Blood Warmer Use

The Utility of Transesophageal Echocardiography in the Initial Perioperative Assessment of Patients Suffering Major Trauma

Awake Fiberoptic Intubation in Patients with Unstable Cervical Spine

Fiberoptic Tracheal Intubation with Combitube in Place

Severity of Blunt Chest Trauma In Patients with Multiple Trauma

EFFECTS OF POSTOPERATIVE AUTOTRANSFUSION IN SPINE SURGERY

B. Riou, M. Guerrero, M. Arock, M. Ramos, P. Viars.

Departments of Anesthesiology and of Emergency Biology, Groupe Hospitalier Pitié-Salpêtrière, Université Paris VI, Paris, France.

In orthopedic surgery, postoperative bleeding may be important. Although the efficacy of postoperative autotransfusion of shed blood in orthopedic surgery has been recently demonstrated, there is still limited data on its biological effects. The goal of our study was to assess these effects after spine surgery.

Patients and methods: After ethical approval and written informed consent had been obtained, 50 patients undergoing spinal surgery were randomly allocated to Control (n=25) and Solco (n=25) groups. Both groups had their postoperatively (5 hrs) drained blood collected (Solcotrans Orthopedic Plus^R) but only the Solco group underwent reinfusion if volume was > 200 ml. Venous blood was withdrawn preoperatively, and 5, 8 and 24 hours postoperatively, and 15 min following reinfusion. Drainage blood was also withdrawn. The following parameters were measured : hematocrit (Ht), platelet count (P), partial activated thromboplastin time (APTT), prothrombin time (PT), fibrinogen (F), and plasma potassium (K⁺), free plasma hemoglobin (fHb) and D-dimers concentrations. Aerobic and anaerobic blood cultures were performed. Data are mean \pm SD.

Results: The shed blood had elevated level of D-dimers, did not clot, was sterile and showed : Ht : 0.26 ± 0.11 ; P : $80 \pm 63 \text{ G.l}^{-1}$; F < 0.1 g.l^{-1} . The volume collected was > 200 ml in 21 patients in the Solco group who were autotransfused ($382 \pm 101 \text{ ml}$, range 200-600 ml), and in 16 patients in the Control group. Within 15 min following reinfusion there was a moderate decrease in P (181 ± 74 vs $224 \pm 90 \text{ G.l}^{-1}$, $p < 0.001$), and F (2.1 ± 0.8 vs $2.3 \pm 0.9 \text{ g.l}^{-1}$, $p < 0.02$), and an increase in circulating D-dimers ($p < 0.001$) without modifications of PT, APTT, Ht, fHb and K⁺. Blood cultures were sterile. No side-effects were observed. There were no significant differences in any biological parameters between the two groups at the 8th and 24 th postoperative hours.

Conclusion: Postoperative autotransfusion is a simple technique with few side-effects. It can be safely associated with other methods used to decrease homologous blood transfusion requirements.

FIBEROPTIC BRONCHOSCOPY IN BRAIN DEAD ORGAN DONORS

B. Riou, R. Guesde, Y. Jacquens, R. Duranteau, P. Viars.

Department of Anesthesiology, CHU Pitié-Salpêtrière, University Paris VI, Paris, France.

The quality of the donor lungs is one of the most significant predictors of the clinical outcome of pulmonary and cardiopulmonary transplantations. Brain death may be accompanied by neurogenic pulmonary edema, thoracic trauma, and aspiration pneumonitis. Criteria for selecting lung donors include normal chest X-ray and adequate gas exchange, but a normal fiberoptic bronchoscopy is not always required. Fiberoptic bronchoscopy has never been assessed in organ donors, although it has been recognized as a valuable diagnostic tool in chest trauma and aspiration pneumonitis. We conducted a prospective study of fiberoptic bronchoscopy in brain dead donors scheduled for a multiple organ procurement.

Patients and methods: Criteria for inclusion were : 1/ brain death ; 2/ multiple organ procurement was scheduled ; 3/ fiberoptic bronchoscopy (Olympus BF10) could be performed by a highly trained bronchoscopist before going to the operating room. Chest X-ray was performed in a supine position and analyzed by a blind observer (normal/abnormal), arterial blood gas analysis was performed under an FiO₂ of 100 %. The following diagnosis could be made during fiberoptic bronchoscopy : 1/ normal; 2/ inhalation of blood ; 3/ inhalation of gastric contents; 4/ pulmonary contusion; 5/ purulent bronchial secretions. Cardiac evaluation was performed using a Swan-Ganz catheter or transesophageal echocardiography.

Results: 72 brain dead donors were included, mean age 38 ± 13 yrs. Chest X-ray was normal in 37 (51%) donors, and the PaO₂ was greater than 400mmHg with an FiO₂ of 100 % in 34 (47%) donors. Fiberoptic bronchoscopy was normal in only 24 (33 %) donors. In the remaining 48 donors, inhalation of blood (n=17) or gastric contents (n=16), pulmonary contusion (n=5), or purulent bronchial secretions (n=9) were noted. In the 26 donors with normal chest X-ray and a PaO₂ greater than 400 mmHg with an FiO₂ of 100%, fiberoptic bronchoscopy was abnormal in 10 (38%) donors. In 33 donors with a Swan-Ganz catheter, the arteriovenous difference in oxygen content (2.4 ± 0.8 ml O₂/100ml), and pulmonary shunt (0.30 ± 0.11 , range 0.13-0.49) were measured. In the 15 donors with a PaO₂ greater than 400mmHg, pulmonary shunt was 0.23 ± 0.07 , range 0.13-0.35.

Conclusion: Chest X-ray and arterial blood gas analysis are not sufficient, and fiberoptic bronchoscopy should be routinely performed to select lung donors. In donors with a normal fiberoptic bronchoscopy, measurement of pulmonary shunt, and not only PaO₂, should be performed to assess pulmonary gas exchange.

PREHOSPITAL MONITORING OF BODY TEMPERATURE IN TRAUMA PATIENTS

M. Helm, L. Lampl, B. Maier, K. H. Bock

Department of Anaesthesiology and Intensive Care Medicine,
Federal Armed Forces Medical Center at Ulm, Germany.

STUDY OBJECTIVE: Prehospital monitoring of body-temperature (BT) of trauma patients during (non-alpine) rescue missions, performed by our rescue helicopter. We paid special attention to the number of hypothermic incidents ($BT < 36^{\circ}C$), as well as their possible consequence upon prehospital treatment.

DESIGN: Prospective evaluation of primary rescue missions performed by the rescue helicopter "Christoph 22" over a one year period from 01.12.1990 - 31.11.1991. BT was measured with a Tympanon-Thermometer (G. Metraux, Switzerland) at three different times: Upon arrival at the scene (T_1), at the beginning of transport (T_2) and upon turnover of the patient at the respective hospital (T_3). Standardized patient positioning procedures were used: Patients were positioned upon a vacuum mattress and were covered with a disposable blanket; HME-Filters (Pall Ultipor BB50, Pall Biomedical Products, NY, USA) were used, when patients required endotracheal intubation and ventilation.

RESULTS: Within the total number of primary missions flown during the study period, we were required to treat $N_{Tot.}=228$ trauma patients ($N_{Male}=151$, $N_{Female}=77$).

The BT of patients with entrapment trauma ($N_{ET}=54$, that is 23,7%) was clearly different from that of the others ($N_{non-ET}=174$, that is 76,3%): 98,1% of the entrapment trauma (ET) patients were hypothermic, whereas only 34,5% of the non-entrapment trauma (non-ET) patients were hypothermic. Not only the frequency, but also the severity of hypothermic incidents was in the ET group clearly higher than in the non-ET group: 68,5% with $BT\ 36^{\circ}-34^{\circ}C$, 27,7% with $BT\ 34^{\circ}-30^{\circ}C$ and 1,9% with $BT < 30^{\circ}C$ in the ET group, versus 34,5% with $BT\ 36^{\circ}-34^{\circ}C$, 0% with $BT\ 34^{\circ}-30^{\circ}C$ and 0% with $BT < 30^{\circ}C$ in the non-ET group.

The frequency of hypothermia was in old trauma patients (age > 65 years; $N_{old}=37$, that is 16,2%) higher, than in the overall group: 100% of old patients with ET and 56,8% of old patients without ET showed a $BT < 36^{\circ}C$.

We did not find any correlation between BT and the respective climatic temperature.

We did not discern a significant variation in body temperature between measurements taken at $T_1 - T_3$.

CONCLUSION: Within the study group, hypothermia proved to be a relevant problem. Entrapment trauma patients are regarding both, frequency and severity, especially endangered; just as old trauma patients. Prehospital body temperature monitoring is therefore absolutely essential.

PREHOSPITAL MANAGEMENT OF TRAUMA RESULTING FROM ENTRAPMENT

M. Helm, L. Lampl, J. W. Weidringer, K. H. Bock
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Federal Armed Forces Medical Center at Ulm, Germany.

STUDY OBJECTIVE: Improvement of prehospital management of patients suffering from entrapment trauma (ET). To facilitate such improvement, we evaluate the peculiarities resulting from ET and their impact upon patients pre-hospital treatment.

DESIGN: Retrospective evaluation of primary missions, performed by the rescue helicopter "Christoph 22" from 01.01.1988 - 01.12.1991.

RESULTS: Within a steady mean average of 62,8% of trauma patients we experienced an increase of ET's from 8,3% to 15,9%. Major causes were motor-vehicle (78,4%) and industrial accidents (21,6%). 78,4% of the ET patients were multiply injured, whereby multiple system trauma (defined by TSCHERNE) predominated (49,4% versus 15% in comparison to the total number of primary missions). Double and triple (each 28,6%) as well as quadruple (13,6%) organ system injuries prevailed. In the majority, we upon arrival were confronted with vital disruptions of circulation (65,2%) and/or respiration (58,1%), which required (in close coordination with the extrication team) immediate therapeutic measures. On an average, one half of the volume of prehospital infusion ($V_{tot}=2400ml$) was administered while the patient was still entrapped. 30,9% of the patients required endotracheal intubation during extrication, 32,2% after release, whereby pulse oximetric monitoring was a decisive help in determining time and method of required therapeutic measures. 89,5% of the victims required analgesics. Especially during extrication, where accessibility to the patient was restricted and treatment possibilities were limited, Ketamine in sub-narcotic dosage was of great assistance.

CONCLUSION: Within the study group, the number of ET's is constantly increasing. It shows an above average proportion of multiple system trauma. Prehospital measures must be in close coordination with the extrication team. Adequate hospital is a trauma center.

EFFECTS OF VARIOUS DIALYSATES ON THE REMOVAL OF THEOPHYLLINE USING CAVHD.

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Introduction:

Continuous arteriovenous hemodiafiltration (CAVHD) has been proven effective in managing fluids and electrolytes in critically ill patients. Removal of drugs by CAVHD has been demonstrated however low hourly clearances limit its applicability in treating drug intoxications(1-4). We designed an in-vitro method of assessing the effects of different dialysates on the clearance of theophylline(Theo) with CAVHD.

Methods:

One liter heparinized bovine blood was mixed with 100 mg theophylline and held at a height of 130 cm(driving pressure of 100 mm Hg). After arteriovenous priming with 1 liter heparinized normal saline(NS) the dialysate/filtrate side of the cartridge(Amicon 20) was primed with either NS, 25% albumin (followed by 5% albumin as the dialysate)(AB) or 6% hetastarch(H). The blood was infused through the cartridge (flow rates about 150 mL/min) and the dialysate flowed countercurrent at 500 mL/hr. Towards the end of the infusion, samples were taken from the arterial(A), venous(V), and filtrate(F) ports for Theo measurement. Each experiment consisted of 6 cycles of infusions and was repeated 5 times using fresh cartridges and blood. The volume lost(Vol) during each of the six runs was measured and replaced with heparinized saline. Sieving coefficient(SC) was calculated as $2F/(A+V)$. Clearance(Cl, mL/min) was calculated as total quantity removed/[A]x time(min). Statistical analysis was performed using ANOVA with $p < 0.05$ indicating statistical significance.

Results:

We found a statistically significant difference in SC and Cl for AB vs NS and H. There was no such difference between H and NS for SC and Cl. For Vol there was no statistical difference between AB, NS or H (Table 1).

Discussion:

When AB was used as the dialysate solution we found the CAVHD cartridge functioned more efficiently at removing Theo than when NS or H was used. The improved SC indicates the actual increased conductance of Theo across the cartridge. The absence of an increased Vol indicates the convective element of Theo removal is not improved by AB. We could not demonstrate any improvement in conductive or convective elements by using non-protein colloid dialysate as H was not different from NS for all parameters. The result is a significantly improved Cl when AB is used as the dialysate. We speculate this improvement to result from trapping unbound Theo on the filtrate side as a result of protein binding to AB (Theo is 50% protein bound) and/or the Donan equilibrium (however, theophylline is weakly basic and so is albumin). Further study is required to evaluate how AB improves CAVHD efficiency and if this application of CAVHD is feasible for the treatment of human Theo intoxication.

Table 1.

<u>Dialysate</u>	<u>SC</u>	<u>Vol (mL)</u>	<u>Cl (mL/min)</u>
AB	0.76±.21*	39.7±8.3	12.76±4.2*
NS	0.54±.18	33.3±16.2	8.23±5.4
H	0.51±.22	32.7±15.5	8.11±3.1

* indicates statistical significance

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DOSE-RESPONSE STUDY OF OXYGEN TRANSPORT AND HEMODYNAMIC EFFECTS OF MILRINONE IN CRITICALLY-ILL PATIENTS

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[PROSPECTIVE AWARD SCIENTIFIC ABSTRACT SUBMISSION]

PURPOSE: Current evidence suggests high-risk and major trauma ICU patients require "supraphysiologic" hemodynamic values (resulting in increased oxygen and nutrient delivery to the tissues) to optimize their chances for survival.^{1,2} While catecholamines have traditionally been used to support cardiac function, a new mechanism of pharmacologic support became available with the introduction of phosphodiesterase (PDE-III) inhibitors. PDE-III inhibitors may produce less tachycardia, fewer arrhythmias, less increase in myocardial oxygen consumption, and demonstrate less tachyphylaxis than catecholamines. In addition, the PDE-III inhibitors exhibit antithrombotic properties, unlike the pro-coagulant activity of catecholamines. A new stable, more potent, second generation PDE-III inhibitor, milrinone (PRIMACOR™) is now available. Milrinone has a shorter half-life of elimination (1-2 hours), a lower incidence of thrombocytopenia, and may be a more potent and specific pulmonary vasodilator than amrinone. Thus, milrinone may be preferable in ICU patients where long-term infusion is likely. The objectives of this study are therefore to: 1.) evaluate the effects of two doses of milrinone on hemodynamics in ICU patients, 2.) evaluate the effects of these doses of milrinone on oxygen transport indices (oxygen delivery, oxygen consumption, oxygen extraction ratio, and shunt), and 3.) evaluate the safety of i.v. milrinone in ICU patients.

METHODS: After IRB approval and informed consent, 12 ICU patients with one or more organ system failure monitored with systemic arterial and pulmonary arterial catheters, will be randomized to one of two loading doses of milrinone (33.5 µg/kg, N = 6, and 75 µg/kg, N = 6) followed by an infusion of 0.5 µg/kg/min for one hour. Baseline hemodynamics (heart rate, systolic, diastolic, mean pressures, cardiac output, and oxygen transport indices) will be repeated immediately after the loading dose of milrinone, and 5, 15, 30, and 60 min later during milrinone infusion. Exclusion criteria include minors (< 18 years age), renal failure (creatinine > 2.5 mg/dL), arrhythmias (requiring antiarrhythmic therapy), previous PDE-III therapy (within previous 48 hours), and severe thrombocytopenia (platelet count < 50,000 µL). Primary and derived variables will be presented as means +/- SEM, and analyzed by repeated measures ANOVA. A P < 0.05 will be considered significant.

SUMMARY: In ICU patients, catecholamine infusions frequently produce inadequate results or untoward side-effects, and patients may exhibit "catecholamine resistance." Utilization of PDE-III inhibitors could offer additional pharmacologic choices to improve myocardial performance and enhance tissue oxygen delivery. New agents such as milrinone, alone or in combination, may restore hemodynamic performance, improve care of critically ill patients, and ultimately increase patient survival.

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DIAPHRAGMATIC PERFORMANCE IN VENTILATED EWES.

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Inspiratory-muscle fatigue is an important aspect of respiratory failure in many clinical conditions where mechanical ventilation often becomes a necessity, providing rest to the fatigued diaphragm. Mechanical ventilation is also used prophylactically in patients with head injury, even if they have no need for respiratory muscle rest.

Patients in Intensive Care Units are often ventilated for several days and sometimes weeks. However, little is known about the effects of prolonged mechanical ventilation on respiratory muscle performance. In particular, if observations from other skeletal muscles apply also to the diaphragm, disuse atrophy with reduced muscular strength can be expected.

An experimental model of prolonged, uninterrupted mechanical ventilation lasting seven days will be developed in adult normally fed, non-paralyzed ewes. Diaphragmatic performance, as reflected by the maximal transdiaphragmatic pressure twitches elicited by phrenic nerve stimulation, will be measured every twenty-four hours in eight ventilated ewes. At the end of each experiment, both the ventilated and four control ewes will be sacrificed. Their diaphragm will be subjected to post-mortem morphometric and histochemical examinations, looking for evidence of disuse atrophy in the ventilated animals.

The two hypotheses to be tested are: 1. Prolonged mechanical ventilation induces a decrease in diaphragmatic performance relatively quickly, i.e., within a week. 2. Prolonged mechanical ventilation produces diaphragmatic disuse atrophy, revealed on post-mortem examinations.

A better knowledge of diaphragmatic performance during prolonged mechanical ventilation could help us tailor ventilatory support, limiting it to the amount sufficient to overcome the extra work of breathing caused by the disease. This would help to avoid disuse atrophy of the diaphragm which may otherwise become apparent when weaning is first attempted. Therefore, these experiments could provide insights into the problem clinicians face when trying to wean patients from the ventilator after prolonged mechanical ventilation. In fact, disuse atrophy could contribute to inspiratory-muscle fatigue, which is a well recognized cause of weaning failures.

Finally, an experimental model of prolonged mechanical ventilation in non-paralyzed animals has not yet been developed, despite the fact that it closely mimics a frequent clinical situation. Therefore, this model could become useful for other areas of investigation in Critical Care Medicine.

THE LARYNGEAL MASK AIRWAY: FIRST CLINICAL EXPERIENCE IN
ALEXANDRIA UNIVERSITY HOSPITALS.

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The laryngeal mask airway consists of a tubular oropharyngeal airway to the distal end of which is sealed a silicon laryngeal mask with an inflatable rim which provides an airtight seal around the larynx. Anaesthetic techniques and drugs used were conventional and similar to those which would have been used for the same procedure if face mask or tracheal intubation had been employed. Blind insertion of the laryngeal mask airway size 4 was successful at the first attempt in 80 patients (out of 100), some manipulation was required in 16 patients, and correct insertion was impossible in 4 patients who required tracheal intubation. Laryngeal mask airway provided a clear airway in 96 out of 100 elective patients for a wide variety of surgical procedures, ranging from minor gynecological and urological procedures to major abdominal surgery with either spontaneous respiration or intermittent positive pressure ventilation. The LM airway does not require laryngoscopy or muscle relaxants for its insertion, it relieves the anaesthetist's hands from holding a face mask during spontaneous respiration and facilitates positive pressure ventilation within the normal tidal volume and airway pressure. It has been used successfully in patients of difficult or failed intubation.

METHOD OF CORRECTION OF LIFE CYCLE OF CELLS IN PATIENTS AT CRITICAL CONDITIONS.

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Connection among changes of metabolic-functional characteristics of erythrocytes and leukocytes of venous blood and changes of life /and mitotic/ cycle of cells of organism was discovered in patients after implantation of valves of heart.

Changes of characteristics of erythrocytes and leukocytes - showing the state of cells in G_1 and G_2 periods of mitotic cycle and are good for the surviving of cells G_0 period /optimum for subsequent crossing to M and S periods/ in erythrocytes-increase ratio K^+/Na^+ ; lactic acid /pyruvic acid /LA/PA/; 2,3-diphosphoglycerate /inorganic phosphate /2,3-DPG/ P_i /; decrease glutathione oxidative/glutathione reductive /GSSG/GSSH/; in leukocytes-decrease of relative activity of dehydrogenases /DG/-succinate DG/ lactate isocitrate DG/LDG /ICDG/LDG/ and to complete inhibition activity of DG after increasing membrane potential /hyperpolarization/. Favourable situation for above said changes - the period of falling asleep /at the background of thiopentali Na/, anaesthesia NLA II.

Changes of characteristics of erythrocytes and leukocytes - showing state of cells in M and S periods of mitotic cycle and are nonfavourable for the surviving of cells at G period /optimum for subsequent crossing to G_1 and G_2 periods and for specialization of cells/: in erythrocytes-decrease K^+/Na^+ ; 2,3-DPG/ P_i ; LA/PA; increase GSSG/GSSH; in leukocytes-increase activity of DG /depolarization/. This nonfavourable situation for the surviving of cells occurs when using high draughts of dopamine for a long time /erosions of mucous layer of a gastric-intestinal tract, erythropoiesis inhibition, skin necrosis of lower extremities/.

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EFFECTS OF BODY POSITIONING IN PATIENTS WITH ARDS FOLLOWING MULTIPLE TRAUMA

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Adult respiratory distress syndrome (ARDS) is a serious complication in patients with major trauma requiring prolonged ventilation. As atelectasis formation may cause additional impairment we hypothesized that turning patients with ARDS over into a prone position might improve gas exchange and lung mechanics.

Patients/Methods: Seven patients (age 18 - 67; 5 males) with ARDS following multiple trauma (ISS 35 - 57) were investigated. Entry criteria were $pO_2 < 100$ mmHg with pressure limited (max 35 mmHg) IRV (I:E = 2:1) at $FiO_2 > 0.5$ and PEEP > 8 mmHg and radiologic signs of ARDS for > 24 hours following admission at the ICU. The patients were turned over into a prone position at noon and were turned back at 8.00 on the next day (study period); following nursing care and evaluation, they underwent another cycle if necessary. Except for FiO_2 , the ventilator setting remained unchanged during the study period. All patients were sedated and sometimes paralyzed to minimize patient discomfort and received our usual standard of care. **Data collection:** Immediately before and 30 min after each position change ventilator setting and hemodynamics were recorded and blood was drawn for BGA and lactate determination. A total of 46 cycles (3 - 8 per patient) were completed. **Data evaluation:** static compliance, pO_2/FiO_2 ratio, AaDO₂, FiO_2 , pH, pO_2 , pCO_2 , lactate levels, MAP, HR and catecholamine requirements were recorded during all 46 cycles; CI, MPAP, PCWP, RVSWI, LVSWI, SVR, PVR, Qs/Qt and oxygen extraction ratio were evaluated from 9 cycles in 3 patients. Data are presented as mean \pm SD; $p < .05$ was considered significant (Student's paired t-test).

Results: All patients survived and were discharged from the hospital. Relevant findings are given in the table:

Position	Parameter	pO_2/FiO_2	AaDO ₂ mmHg	FiO_2	pO_2 mmHg	MAP mmHg	HR b/min	CI l/min/m ²	MPAP mmHg	PCWP mmHg
1 supine (last)	mean	164	277	0.59	96	85	128	4.8	26	10
	SD	36	69	0.11	21	14	12	0.9	5	3
	sign. vs	2,3,4	2,3,4	3,4	2,3,4	2,4	3		2,3	2,3
2 prone (30')	mean	250	220	0.58	144	91	125	5.2	29	12
	SD	60	57	0.09	40	12	15	0.8	4	4
	sign. vs	1,3,4	1,3	3,4	1,4	1,3	3		1	1
3 prone (last)	mean	277	181	0.51	138	87	112	4.9	29	13
	SD	69	58	0.07	28	13	13	1.1	3	4
	sign. vs	1,2,4	1,2,4	1,2,4	1,4	2	1,2,4		1	1,4
4 supine (30')	mean	199	232	0.55	108	89	124	4.7	27	10
	SD	57	50	0.07	31	13	18	0.9	6	3
	sign. vs	1,2,3	1,3	1,2,3	1,2,3	1	3			3

Following the change from a supine to a prone position, compliance remained unchanged at 26, whereas AaDO₂, pO_2 and pO_2/FiO_2 ratio improved significantly. The pH, BE, pCO_2 and lactate levels showed no changes, MAP increased slightly, and HR decreased markedly under identical catecholamine doses. Cardiac index and filling pressures rose slightly, SVR, PVR, LVSWI and RVSWI remained unchanged. Shunt fraction decreased slightly (20 to 18%) but insignificantly. Oxygen extraction ratio decreased significantly from 0.3 to 0.22. A major part of all these improvements was lost when the patients were turned back. All patients showed markedly improved chest X-rays following their first study cycle.

Discussion: The prone position seems to be superior to the supine position for patients with ARDS following trauma, as hemodynamics and oxygenation are significantly improved, while contrary to our hypothesis lung compliance did not change. In our opinion, it seems important to start early, thereby avoiding rather than treating major atelectasis formation. Short periods in the supine position are necessary to allow for nursing care, medical evaluation and interventions such as placement of central lines. Major problems with this technique are the unavoidable development of facial edema, the critical periods of turning, when the risk of unintentional extubation or loss of intravascular lines is high, and the difficult conditions for treatment of complications (e.g. loss of airway or CPR). Brain edema, unstable vertebral injuries, and an unstable thorax must be regarded as contraindications.

Conclusion: Prone positioning is an effective treatment of trauma patients with ARDS. In comparison to the only effective alternative (kinetic positioning using rotating beds) prone positioning is "low-tech" and less expensive, but requires dedicated and skillful nursing staff.

OXYGEN DELIVERY CHARACTERISTICS OF THE HUDSON MASK WITH RESERVOIR BAG

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Oxygen therapy is an essential component of the treatment of the trauma victim. There is a need for a system that delivers oxygen at a high inspired concentration, independent of alterations in ventilatory pattern. The Hudson non re-breathing reservoir mask system is purported to fulfil this requirement ¹. This has not been formally tested and therefore we have investigated it experimentally.

A mechanical lung model with sine-wave respiratory flow pattern was used to simulate spontaneous ventilation². The analogue lung was attached to a mannequin face model (mask-patient interface), tidal volume was set at 400 mL and respiratory frequency was varied at 15, 20, 25 and 30 breaths per minute. Respiratory flow rates were obtained using a pneumotachograph and oxygen concentrations in the model trachea were measured using a mass spectrometer. The oxygen flow to both masks was set at the recommended gas flow-15 L/min. Effective inspired oxygen concentration was taken to be the end-expired value as this equilibrates with the alveolar concentration in the lung model where there is no uptake of gases.

The ranges of O₂ concentrations for both type of masks were similar, ranging from 60-80%. The relationship between FIO₂ and ventilatory parameters are presented in figures 1 & 2.

This study demonstrates that the performances of both devices are similar being dependent on both respiratory rate and PIFR. Thus the reservoir system confers no advantage over the Hudson mask alone.

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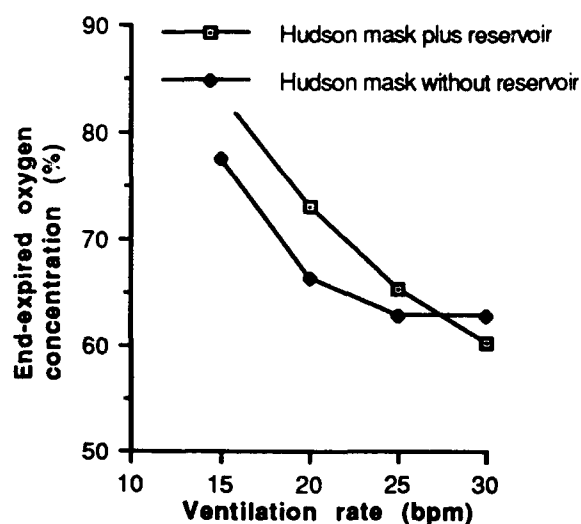


Figure 1: End-expired oxygen concentration versus respiratory rate

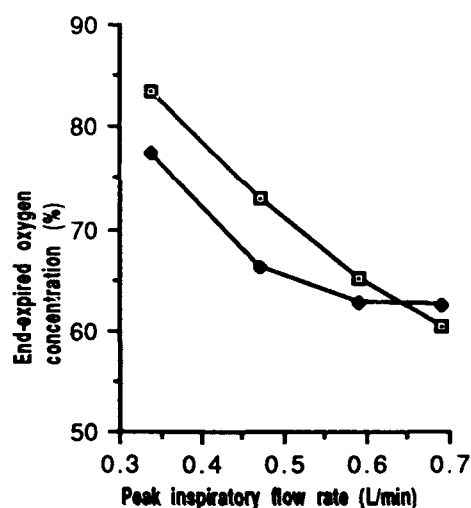


Figure 2: End-expired oxygen concentration versus peak inspiratory flow rate.

INTRODUCTION OF A RESCUE HELICOPTER SERVICE IN KENYA - EXPERIENCES FROM A WORKSHOP AT NAIROBI

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Upon the 25th anniversary of Kenya's independence, the Federal Republic of Germany presented during the festivities a completely equipped rescue helicopter (MBB Bo 105 CBS) to the Republic of Kenya. Included in this present was a training program for pilots, technicians, physicians and flight nurses.

The Dept. of Anaesthesiology of the Federal Armed Forces Medical Center at Ulm was charged with the conduct of this program. This tasking confronted us with hitherto unknown problems, in as much as we had no recourse to previous rescue helicopter experience in any other comparable african country. In cooperation with our kenyan partner, a twofold training program was developed. It was structured to provide kenyan physicians and flight nurses an introduction to the german rescue helicopter service at our hospital and the conduct of an emergency seminar of three weeks duration by two of our physicians in Nairobi/Kenya. This emergency medicine seminar in Nairobi included:

1. Theoretical training and practical emergency medicine case studies.
2. Introduction to and practical application of medical equipment installed in the rescue helicopter, including flight exercises.
3. Mission tactical advice. We considered this part to be of special importance, because the installation of a sensitive and complex system, such as a rescue helicopter, especially in a country, which lacks both, the necessary ground control centers and the required radio communication means, can only be succesful, if it starts with conducting secondary missions, that is inter-hospital transfer. This, at least in the beginning, helps to circumvent the insecurities, which are resulting from inexperience and a lack of sufficient guidance from ground control centers.
4. Introduction of the rescue helicopter at various provincial hospitals. Briefing and training of personnel on the emergency medical potentials of this rescue helicopter, as the first step in the construction of a secondary helicopter transport network.

In spite of considerable problems pertaining to both, personnel and support, there is no doubt, that the high accident rates on one hand and the stressful transport situation on the other hand indicates the need for new emergency medical impulses. A rescue helicopter for the metropolitan area of Nairobi can be such an impuls.

PERIOPERATIVE MANAGEMENT OF SEVERE TRAUMA PATIENTS

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We reviewed 30 cases of severe trauma that caused by traffic accident and industrious injury; 14 cases with severe closed head injuries(CHI)(14/30;46%). 5 cases with severe multisystem organ injuries(MOI,5/30;16.7%). 11 cases with liver or spleen injuries (11/30;36%). Themortality of whole group was 10%(3/30).2 deaths were related to CHI with brainstem injury, one was related to multisystem organ injury with great vessel rupture.

This article focuses on the acute perioperative management of the severe trauma patient. It was of paramount importance that the trauma patient be rapidly assessed and supported in the E.R. and need to immediarely apply the ABCDs of trauma care; A very standard primary survey (established an open airway, assure gas exchange, maintain the circulation, and evaluated the basic neurologic states) with ongoing resuscitation and immediate surgical intervention when required.

Intraoperative management: Induction; Epidural anesthesia was of particular benefit for analgesia as well as anesthesia of isolated injuries(i.e spleen or liver injuries). General anesthesia was indicated in major trauma associated with short acting intravenous drugs(i.e fentanyl; sufentanil) or low doses of inhaled agents(i.e Enflurane or Isoflurane) as tolerated. Atracurium was the first-choice of muscle relaxant. Arterial B.P. was recorded via a radial arterial catheter(Sirecest Siemens 960) and blood gases were monitored(computer control JBA-150K Blood gas Analyzer) intraoperatively. Postoperation considerations; patients were sent to ICU for further treatment and monitored.

PERIOPERATIVE MANAGEMENT OF SEVERE TRAUMA PATIENTS

Jian Yun Song, Dept. of Anesth., Gan Quan Hospital, Shanghai Railway Med. College, Shanghai, P.R.China.

We reported 30 cases of severe trauma victims caused by traffic accident and industrious injury; 14 cases with severe closed head injuries(CHI)(14/30;46%), 5 cases with severe multisystem organ injuries(MOI, 5/30;16.7%), 11 cases with liver or spleen injuries(11/30,36%). The mortality of those patients was 10%(3/10); two deaths were related to CHI with brainstem injury, another one was related to multisystem organ injury with great vessel injury.

This article focuses on the acute perioperative management of the severe trauma patients. It was of paramount importance that the trauma patients be rapidly assessed and supported in the E.R. and needed to immediately apply the ABCDs of trauma care; A very standard primary survey(establish an open airway, assure gas exchange, maintain the circulation, and evaluate the basic neurologic states) with ongoing resuscitation and immediate surgical intervention when required.

Intraoperative management: Induction; Epidural and local block techniques were be of particular benefit for analgesia as well as anesthesia of isolated injuries. General anesthesia was indicated in major trauma associated with hypovolemia. Maintenance; were be provided with short acting intravenous drugs or low doses of inhaled agents as tolerated. Atracurium was the first choice of neuromuscular blocking agent.

Postoperation considerations; Patients were routinely sent to SICU for further management and monitoring.

According to the different injuries of those patients, we took three classes of monitoring for them; Routine monitoring(HR, R, BP; EKG, SpO₂); Higher monitoring(routine+ Blood Gases Analysis, CVP). Highest monitoring(Higher monitoring+ invasive BP, MAP, TEMPERATURE, URINE etc.) provided to A.S.A. 4 or 5 patients(severe CHI or and MOI injuries). Higher monitoring used to A.S.A. 3 grade patients, and routine monitoring were used for A.S.A. 2 or 3 patients without hypovolemia.

DETERMINATION OF VECURONIUM REQUIREMENTS IN THE THERMALLY INJURED PATIENT
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Thermally injured patients have been previously shown to be resistant to non-depolarizing muscle relaxants, including d-tubocurarine, pancuronium, metocurine, and atracurium. Vecuronium has been previously studied only in pediatric burn patients,¹ with significant resistance demonstrated. The purpose of this study was to determine the ED95 of vecuronium in the thermally injured patient.

The study was approved by the Institute of Surgical Research and Brooke Army Medical Center Human Use Committees. Patients 18 years of age or older, scheduled for excision and grafting of their burns, >1 week postburn, with burns >33% of the total body surface area (BSA) were included in the study.

General anesthesia was induced with intravenous anesthetics, supplemented with nitrous oxide. Normothermia was maintained, and no volatile anesthetics were utilized during the study portion of the anesthetic. The ulnar nerve was stimulated with a train-of-four supramaximal square wave pulse repeated every 12 seconds and the evoked tension of thenar adduction was measured by a force transducer. Once the train-of-four twitch height was stable for 3 min, 30 mcg/kg of vecuronium bromide was administered intravenously. Maximal twitch height depression was recorded. An incremental dose required to achieve 95% twitch height depression was calculated and administered intravenously.² The maximal effect of this second dose was recorded.

The same protocol was studied in 25 unburned control patients to yield an ED95 for vecuronium in unburned patients. Control patients received an initial dose of 20 mcg/kg of vecuronium, and the ED95 was then calculated as described above.

The individual data was analyzed to determine an average ED95 for the entire cohort. This data was analyzed for standard deviation and a Students t-test was used to ascertain if a statistically significant difference existed in the ED95 between thermally injured and nonthermally injured patients.

The calculated ED95 dose for the 25 control patients was 39.7 ± 9.2 mcg/kg (mean \pm SD). This is comparable to the ED95 quoted in the literature (40-50 mcg/kg). The calculated ED95 for the 14 burned patients was 67.2 ± 25.1 mcg/kg. This difference in ED95 between burned and control patients was statistically significant ($P < .001$). The degree of resistance seemed to increase with the size of burn (33-48% BSA vs. >50% BSA).

	number	size burn (TBSA %)	ED95 (mcg/kg)	P value
control	25	0	39.7 ± 9.2	
burned	14	53.6 ± 15.2	67.2 ± 25.1	* <.001
<50% BSA	9	44.2 ± 4.3	54.2 ± 17.7	# .0036
>50% BSA	5	70.6 ± 12.4	90.6 ± 19.1	+ .0037

* Control versus thermally injured patients; # Control versus total burn 33-48%;
+ Total burn 33-48% versus total burn > 50%

This study confirms the resistance of vecuronium bromide in thermally injured patients.

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AIRWAY RELATED COMPLICATIONS OF EMERGENCY INTUBATION

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Airway management in an emergency setting can be fraught with difficulties including a full stomach/ aspiration risk, inadequate airway assessment, minimal time to assess the patient's current physical condition and coexisting medical problems. Various induction techniques are used in the OR to minimize patient morbidity¹, but the uncontrolled environment outside the OR offers a unique challenge to anesthesia personnel.

1037 patients who underwent intubation for acute deterioration due to cardiac, pulmonary, septic, traumatic or neurologic related disease (age 18-95yrs) were evaluated in a prospective, non-randomized manner. The intubator completed a questionnaire following airway management and a separate evaluation was completed by the author (TM) following ICU admission and stabilization.

Complications were categorized and evaluated to compare differences between the level of experience of the intubator, patient's age and disease category. Post intubation chest x-ray confirmed proper placement of the endotracheal tube. Hypoxemia was defined as O₂ saturation <85% by pulse oximetry. Aspiration was confirmed by the suctioning of gastric contents via the endotracheal tube. Cardiac arrhythmia was defined as a new rhythm arising at the time of laryngoscopy and intubation. Data analysis by Chi-square, Student's t-test, and ANOVA methods was performed.

Overall, the number of complications, (including extreme hemodynamic changes) were 1343, with 70% of patients experiencing at least one mishap. 427 total adverse effects of intubation related specifically to the airway occurred among the entire group. Specifically, 322 of 1037 patients (31%) experienced at least one major mishap with several experiencing more than one (105 patients). Delayed recognition of a main stem bronchus intubation occurred in 39 cases (4%). Twenty one per cent (213) of all patients experienced hypoxemia during airway manipulation. Multiple laryngoscopies (>3) was associated with a 93% incidence of hypoxemia (84 cases). Seventy-two patients experienced esophageal intubation (7%). Of these, 57 of the 72 patients (80%) experienced hypoxemia related to misplacement of the ETT.

Ten cardiac arrests and 19 symptomatic bradycardic rhythms requiring therapy with atropine appeared to have hypoxemia as a causative factor. Regurgitation of stomach contents (55 patients) was associated with 49 episodes of hypoxemia (89%). Clearly, 35% of the episodes of regurgitation were related with aspiration (19 cases, 1.9% overall) and all 19 episodes lead to hypoxemia. Esophageal intubation increased the risk of regurgitation 7-fold ($p < .0001$), and aspiration 10-fold ($p < .001$). Nine percent (15/176) of patients regurgitated gastric contents despite the application of cricoid pressure. Accidental extubation after intubation (5 cases) resulted in 4 hypoxemic episodes and 1 episode of regurgitation and aspiration. There were 48 intubation related atrial and ventricular arrhythmias. Thirteen (13) episodes of asystole (10 hypoxemic induced) and one episode of ventricular tachycardia were each associated with cardiac arrest and CPR. ICP monitoring revealed increases in 7/8 patients, with ICP increases ranging from 40% to 550% above baseline. An emergency surgical airway was required in 6 cases, each related to hypoxemia. Additionally, 3 cases of regurgitations and 2 hypoxia induced bradycardic rhythms were present in this select group. No differences in complication rates were found among resident CA-1,2,3 levels and staff members. Patient age and disease category appeared to have no correlation to complication rate.

In conclusion, the margin of safety is tenuous when emergency airway management is required outside the operating room. Airway related morbidity appears to occur in 1 of 3 patients. Emphasis in resident education should stress the importance of careful management with optimal preoxygenation, full stomach precautions and rapid verification of endotracheal tube placement. Additionally, our education should reinforce the tremendous increase in risk associated with critically ill patients requiring emergency airway control.

References: (1) Anesthesia, Miller, 1989, p555

PREHOSPITAL MANAGEMENT OF ELDERLY TRAUMA PATIENTS

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Study objectives: The present study examined the differences between elderly (ETP) (age \geq 65y) and nonelderly trauma patients (NTP) (age $<$ 65y) focused on mechanism, pattern and severity of injury and prehospital mortality in order to optimize the treatment of these patients.

Methods: We retrospectively evaluated the prehospital data of 1640 trauma victims, treated by the medical team of our rescue-helicopter "Christoph 22", over a period of 5 years (1988-1992). The groups were compared using χ^2 -analysis and the Mann-Whitney U-test.

Results: 166 ETP (10%), mean age 75y (65y-103y), and 1474 NTP (90%), mean age 27y (2w-64y), were entered into the study. The ETP-group included significantly more women than the NTP-group (39% versus 27%, $p<0,01$). For both groups traffic accident was the most common reason of trauma (63% versus 73%), followed by occupational accidents of NTP (13%) and domestic accidents of ETP (23%). ETP were more likely to suffer trauma from fall (24% versus 10%, $p<0,001$) and cardiocirculatory, cerebral or endocrine disease (4,2% versus 0,9%, $p<0,001$).

According to the NACA-score ETP were more severely injured than ATP (4,51 versus 4,25, $p=0,01$), but the rate of multiple injury (23%) and the number of injured body regions did not vary: One single region (39%), two (30%), three (18%) or at least four regions (12%) were affected with the same frequency. Trauma of head (70%) and abdomen (22%) occurred with comparable incidence for both groups. Spine and extremity were injured less frequently in ETP (61% versus 72%), whereas chest injury significantly increased (49% versus 41%, $p<0,05$). The incidence of chest injuries caused by motor vehicle crash showed clearly the difference between ETP and NTP (74% versus 57%, $p=0,01$).

ETP more likely died from trauma before admission to hospital (8,4% versus 4,2%, $p<0,05$).

Conclusion: Preexisting diseases, a slightly increased injury severity and a doubled mortality rate of elderly trauma victims should lead to an aggressive diagnostic and therapeutic approach even in cases of relatively moderate injury. Especially the important role of chest trauma should be taken into account.

GUIDELINES AND NEW TECHNIQUES: AN INTELLECTUAL CHALLENGE.

John Schou, M.D.
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Much energy is invested in development of guidelines for emergency procedures. This is necessitated by the relative absence of the experts in the front line and thus the need for strict, if not necessarily simple recommendation for the management of certain, well-defined emergencies. These recommendations protect the patient against unnecessary improvisations out of ignorance.

However, this process is not without adverse effects: (1) in the absence of standardized patients, it is impossible to define guidelines for all emergencies; (2) guidelines represent a "square" approach to finely differentiated clinical pictures; (3) guidelines seldom respect different capabilities among those supposed to carry them out and in doing so, (4) guidelines may virtually restrict the readiness to accept novel techniques and principles [1].

How strong this repulsive effect is, was experienced by the author on presenting alternative (though not necessarily better) anesthetic techniques and on suggesting antagonization as more than occasional alternative to intubation and ventilation in drug overdose (referred in [2]). In this contribution, the audience is given opportunity to test its own open-mindedness to heretic suggestions in apparent conflict with the most excellent guidelines for emergency care.

The AHA standards and guidelines for CPR and ECC [3] is a masterpiece of rational recommendations based on an extensive literature survey, and they render high esteem internationally. They cannot, however, prophesy new developments. Active Compression-Decompression (ACD) [4] is such a novelty. In our own work with this device [5], we were not only clinically impressed by its effect, we also recognized the need for deviation from the AHA recommendations concerning frequencies of compression and ventilation. In order to produce sufficient decompression, the compression-rate cannot exceed 60/min but 40/min is also acceptable; and in order not to destroy the effect of this decompression, positive-pressure ventilations should be minimized (we use 4 inflations/min while ACD in itself produces a considerable ventilation).

The latter effect may also offer a new approach to paramedic's CPR before endotracheal intubation can be carried out. In spite of a variety of measures to maintain free airways during ventilation, gastric air distention and subsequent aspiration remains a frequent problem. When using ACD, it is perhaps better for paramedics incapable of performing intubation to avoid active ventilation during the initial phases of CPR and concentrate on free airways and oxygen supply. Of course, this hypothetical suggestion demands further support in clinical studies before a recommendation can be made!

Essential in this context is the reception of suggestions contrary to (or not included by) acknowledged guidelines — how did you react?

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RAPID RESUSCITATION MAY CONTRIBUTE TO HYPOTHERMIA DESPITE BLOOD WARMER USE

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Objective: Because routine use of "high-efficiency" blood warmers during trauma resuscitations has not eliminated hypothermia, this study was performed to determine whether patients could still be losing heat due to cold infused fluids.

Methods: We tested "high efficiency" blood warmers' abilities to heat blood and saline under a variety of conditions designed to replicate rapid resuscitation. Two coaxial countercurrent warmers (H250, H500) with power outputs of 600 watts and 1200 watts respectively, were each tested with two different tubing sets (D50, D100). We also tested a plate-type warmer (Fenwal). Saline and expired packed red blood cells at 4°C were pressurized to 300 mmHg and administered through 18, 16, and 14 gauge and 8.5 French catheters. Runs were timed to determine flow rates, and effluent temperature was measured with a calibrated digital thermometer. Both cold and warm start-ups were tested.

Results: Temperature varied substantially during administration for all warmer/tubing configurations under some conditions. The table shows highest and lowest observed effluent temperatures, highest flow rate achieved, and plateau temperature at highest flow rate (ml/minute).

Warmer:	H500	H500	H250	Fenwal
Tubing:	D100	D50	D50	
Highest temperature	37.8	35.9	35.6	34.5
Lowest temperature	18.0	21.5	24.0	30.8
Plateau temperature	35.7	34.6	32.8	33.6
Highest flow (ml/min)	318	167	186	58

Of the tested blood warmers, only the H500 warmer with the D100 tubing set can achieve eutermic (>35°C) fluid delivery at high flow rates (>300 ml/minute), and only when the reservoir is first allowed to reach operating temperature. Other warmer/tubing configurations cannot achieve this standard.

Conclusions: "High-efficiency" blood warmers may decrease but not eliminate heat loss due to transfusion. Of the tested warmers, the Level 1 H500/D100 is recommended for major trauma resuscitations.

THE UTILITY OF TRANSESOPHAGEAL ECHOCARDIOGRAPHY IN THE INITIAL PERIOPERATIVE ASSESSMENT OF PATIENTS SUFFERING MAJOR TRAUMA

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Transesophageal echocardiography (TEE) has become an invaluable clinical tool for the rapid and accurate assessment of cardiovascular pathology. TEE has proven useful intraoperatively and in the intensive care unit (ICU) in detecting major life-threatening conditions and in guiding their treatment (1-3). The utility of TEE in the acute assessment of patients who have suffered major trauma has not been studied. At this center, the authors have implemented a protocol guiding the use of TEE in acute trauma in an effort to evaluate its usefulness in the emergency setting.

A Dasonics Cardiovue 6400 TEE system utilizing a 32 linear element 3.5 MHz monoplane probe is used to study trauma patients who are brought to the operating room for emergent procedures. Indications for TEE study include (1) major trauma to the chest, thorax, or abdomen, (2) major trauma to two or more limbs, (3) hypotension refractory to fluid therapy, and (4) known history of cardiac disease. Contraindications include (1) known esophageal disease or significant injury, (2) esophageal bleeding, (3) major maxillofacial injury, and (4) a history of mediastinal irradiation. Placement of the TEE probe is accomplished after endotracheal intubation and is usually facilitated by direct laryngoscopy. The probe is lubricated generously with surgical jelly to facilitate passage and to improve contact and image quality. Patients are routinely examined in a methodical fashion beginning at the apex of the heart and moving gradually towards the base. Two dimensional echo, color-flow doppler, and pulsed wave doppler are each employed to insure a complete cardiovascular exam. At the left ventricular short axis viewpoint, left ventricular preload is assessed and the presence or absence of tamponade is evaluated. At the midpapillary level, myocardial contractility and the presence of ventricular wall motion abnormalities are assessed. Withdrawal of the probe demonstrates the four-chamber view and allows assessment of semilunar valve function and evaluation of septal wall motion abnormalities. The integrity of the atrial and ventricular septa can also be assessed in this view. Slight withdrawal of the probe reveals the left ventricular outflow track and allows interrogation of the aortic valve. Withdrawal to a level above the aortic valve permits visualization of the coronary anatomy and assessment of the proximal aorta. The probe is then rotated 180° and the descending aorta and aortic arch are interrogated.

We have found that this rapid (total exam time 2-3 minutes) and systematic evaluation of the heart and major vessels provides integral diagnostic information in cases of myocardial contusion, pericardial tamponade, acute aortic dissection, hypovolemia, acute hemothorax, pleural effusion, acute ischemia, and chronic and acute valvular dysfunction. No complications of TEE placement have been encountered to date.

In conclusion, we have found that TEE is useful in the acute perioperative cardiovascular evaluation of patients who have suffered major trauma and that this technique is safe and feasible in these patients in this setting. Future directions include quantification of the relationship between LVEDV and CVP in this population and improved assessment of hemodynamic and anatomic dysfunction.

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AWAKE FIBEROPTIC INTUBATION IN PATIENTS
WITH UNSTABLE CERVICAL SPINE

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Purpose: To evaluate the value of fiberscope in tracheal intubation in patients with unstable cervical spine.

Methods: This is a retrospective review of the records of fiberoptic intubations in 19 male and 2 female patients with unstable cervical spine. All patients received an antisialagogue drug with premedication. Sedation was achieved with fentanyl in combination with diazepam or midazolam. Eight patients with mechanical stabilizers were intubated leaving the supportive devices in place. Topical anesthesia was accomplished as follows: 10% lidocaine spray of the oropharynx, 4% cocaine for nasal mucosa and for laryngotracheal mucosa 4% lidocaine per translaryngeal injection (16 patients) or by "spray as you go" technique (5 patients). The sensory and motor function of the extremities was checked after intubation and prior to induction of anesthesia. One patient had a history of difficult intubation and 10 were expected to be difficult intubations.

Results: Laryngotracheal topical anesthesia was considered good in 18 patients and poor in 3 patients. Two patients had severe cough and five patients had no cough response to the application of topical anesthesia. Successful awake fiberoptic intubation was achieved in all patients, 10 nasally and 11 orally. Fiberoptic laryngeal exposure was easy in 17 patients and moderately difficult in 4. Complications were limited to mild epistaxis in two patients. Neurological examination after intubation was unchanged. Nine patients had no recall, eight had recall of part of the intubation process but indicated it was not unpleasant. In 4 patients this information either could not be or was not obtained.

Conclusion: The limitation of the head and neck movement by cervical disease or imposed by stabilizing devices increases the difficulty or failure rate of rigid laryngoscopic intubation. Securing the airway prior to induction of anesthesia is one approach used to avoid airway difficulties and possible neurological impairment due to head and neck movement in patients with a unstable cervical spine. Awake intubation also provides an opportunity to check neurological status after intubation and prior to induction of anesthesia. The safety of awake tracheal intubation has been questioned since coughing is often associated with this techniques. The results of this study indicate that awake fiberoptic endotracheal intubation is a safe and easily performed technique in these patients and induced coughing was not associated with adverse neurological outcome.

FIBEROPTIC TRACHEAL INTUBATION WITH COMBITUBE IN PLACE

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PURPOSE: The Esophagealtracheal Combitube[®] (ETC) is placed blindly into the esophagus to establish emergency ventilation. Replacement with an endotracheal tube (ETT) may be necessary to provide a more secure airway. This study was conducted to assess the feasibility of fiberoptic trachea intubation with an ETC in place.

METHODS: Approved written informed consent was obtained from 14 patients. After induction of anesthesia and muscle paralysis, blind placement of the ETC was attempted. Fifteen minutes after placement a fibroscope was passed orally to place an ETT. Airway pressure, tidal volume and rate of ventilation were recorded during mask/bag, ETC/bag, ETC/mechanical ventilation and ETT/MV. An arterial blood sample was drawn during mask ventilation, ETC/MV and ETT/MV. The number of attempts, the time and degree of difficulty of tube placement was recorded.

RESULTS: Fourteen patients 64 ± 12 yr. and 82 ± 16 kg were studied. The first five placements caused minor trauma evidenced by bloody secretions. In one patient the fiberoptic intubation failed because of poor relaxation and in the other the ETC tube was removed before intubation (table 1). The tongue became engorged in 8 patients and remained so until the ETC oropharyngeal cuff was deflated. The peak airway pressure (PAP) for ETC/MV averaged 6 cm H₂O higher compared to ETT/MV. Mild or moderate sore throat was reported by 66 percent of patients.

CONCLUSION: Blindly placed ETCs typically entered the esophagus. Endotracheal tube placement using a fiber- scope was successful in all but one patient. Because of the large size of the ETC tube, manipulation of the fibroscope can be difficult. These results demonstrate that the combination of blind placement of ETC tube followed by fiberoptic tracheal intubation can provide an effective means of emergency airway management.

Table 1: Combitube and Tracheal Tube Placement

	Combitube	Tracheal Tube
Attempts		
1	9	12
2	3	1
3	0	0
Failed	0	1
Intub. time *(sec.)		
Average	55	40
Range	15-105	18-150

* For successful attempts

SEVERITY OF BLUNT CHEST TRAUMA IN PATIENTS WITH MULTIPLE TRAUMA

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Chest trauma is a frequent cause of disability and death and the majority of chest injuries occur in motor vehicle accidents (38% of all accidents). The present review was carried out to classify the type of injury, to assess morbidity and mortality of chest trauma and to determine if improvement in preventive steps (seat belts, passive car security, airbag and preclinical treatment) should alter established principles of management.

We investigated 209 consecutive patients with multiple trauma admitted to the emergency room from 1988 to 1990. We evaluated the type of injury, the incidence of chest tube treatment and mortality (McPeck[1]).

150 (71%) patients had head injuries, 124 (59%) chest trauma, 66 (32%) abdominal trauma and 140 (67%) major fractures. Only 9 (4%) had isolated chest trauma. After rib fractures (93;75%) pulmonary contusion (52;42%) was the most common chest injury. Hemothorax was seen in 44 (35%) of chest trauma patients. Pneumothorax was diagnosed in 41 (33%) and tension pneumothorax in 4 (3%) patients. 77 (62%) patients were treated with chest tubes (10% preclinically). The outcome of patients with chest trauma (McPeck-Index 4.2; mortality 22%) was not different from the patients with multiple trauma (McPeck-Index 4.5; mortality 24%).

In conclusion, the incidence of chest trauma in patients with multiple trauma is unchanged compared to data in 1965-1975 [2]. The incidence of hemothorax increased over the last two decades, whereas pneumothorax is seen less often. Especially tension pneumothorax is a rare but nevertheless lifethreatening complication which must be recognized and treated preclinically with a chest tube.

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PLENARY SESSION 5:

PreAnesthetic Preparation of the Trauma Patient

Moderator: Kenneth J. Abrams, MD

Pre-anesthetic Evaluation of the Trauma Patient

Kenneth J. Abrams, MD

Diagnostic Imaging: Implications for the Trauma
Anesthesiologist

Susan G. Kaplan, MD

Monitoring for Trauma Anesthesia

Ruby M. Padolina, MD

Discussion

PREANESTHETIC EVALUATION OF TRAUMA PATIENTS

Kenneth J. Abrams, M.D.

I. Introduction

II. Initial Assessment

III. Scoring Systems

- A. ASA Physical Status**
- B. Glasgow Coma Scale**
- C. Trauma Score**
- D. Acute Physiology and Chronic Health Evaluation**

IV. Respiratory Evaluation

- A. Airway Evaluation and Maintenance**
- B. Maxillofacial Injury**

V. Circulatory Status

- A. Shock**
- B. Classification of Acute Hemorrhage**
- C. Vascular Access**
- D. Assessment of Response to Resuscitation**

VI. Neurological Evaluation

- A. Closed Head Injury**

VII. Cervical Spine Evaluation

- A. Stabilization**
- B. Radiological Evaluation**
- C. Acute Spinal Cord Injury**

VIII. Special Considerations

IX. Summary and Conclusions

DIAGNOSTIC IMAGING: IMPLICATIONS FOR THE TRAUMA ANESTHESIOLOGIST

Susan G. Kaplan, M.D.

I. Introduction: Basic Principles of Diagnostic Imaging

- A. Cathode Ray Tube**
- B. Patient Positioning**
- C. Magnification**
- D. Computed Tomography**
- E. Other Imaging Modalities**
- F. Radiation protection**
- G. Film Series and Interpretation**
- H. Contrast Media**

II. Head Trauma

- A. Common Patterns of Injury**
- B. Anatomy**
- C. Pathologic Conditions**

III. Vertebral Column Injury

- A. Anatomy**
- B. Cervical Spine Injury**
 - 1. Radiographic Examination**
 - 2. Mechanisms of Injury**
- C. Thoracolumbar Injury**

IV. Airway Injury

V. Chest Trauma

- A. Soft Tissue Injury
- B. Thoracic Cage Injury
- C. Pulmonary Injury
- D. Myocardial Injury
- E. Esophageal Injury
- F. Vascular Injury
- G. Diaphragmatic Injury

VI. Abdominal Trauma

- A. Anatomy
- B. Pathologic Conditions
- C. CT versus DPL (Diagnostic Peritoneal Lavage)

VII. Pelvic Trauma

- A. Classification of Pelvic Fractures
- B. Pathologic Conditions

VIII. Extremity Trauma

- A. Upper Extremity
- B. Lower Extremity

IX. Conclusions

MONITORING FOR TRAUMA ANESTHESIA

Ruby M. Padolina, M.D.

I. Introduction

- A. Reasons for Monitoring
- B. Importance of Monitoring in Trauma

II. Principles of Monitoring for Trauma

- A. Establishment of Care Priorities
- B. Efficient, Proper Time Management
- C. Formulation of Care Plan

III. Variables Affecting Monitoring

- A. Priorities of Care Dependent Upon:
 - 1. Rapid Overview
 - 2. Primary Survey
 - 3. Secondary Survey
 - 4. Diagnostic Results
 - 5. Time
- B. Location Where Patient is to be Monitored:
 - 1. Field
 - 2. Emergency Room
 - 3. Operating Room
 - 4. Intensive Care Unit
 - 5. Ward/Floor
 - 6. Home

- C. Severity of Patient's Injuries
 - 1. Injury Severity Score
 - 2. Nature of Injury
- D. Pre-existing and Concurrent Medical Conditions
- E. Expertise of Attending Surgeon and Anesthesiologist
- F. Practicality, Availability of Equipment and Personnel

IV. Goals of Monitoring

- A. Stabilize Vital Signs
- B. Restore Intravascular Volume
- C. Maintain Organ Perfusion
- D. Overall Patient Safety

V. Basic Monitors

- A. Clinical Observer (i.e., Physician, Nurse, Emergency Medical Service Personnel, Non-Health Observer)
- B. Visual Observation (i.e., Patient's Color and General Status, Immediate Surroundings)
- C. Pulse Oximeter (Oxygen Saturation)
- D. Capnograph (End Tidal Carbon Dioxide)
- E. Electrocardiogram
- F. Non-Invasive Blood Pressure Measurements
- G. Urinary Output and Volume Loss Monitor
- H. Sensory and Motor Function (Peripheral Nerve Stimulator)
- I. Mental Status, Neurological Check
- J. Monitors in Anesthesia Machine (i.e., Oxygen Analyzer,

Pressure Alarm Monitor, Mass Spectrometer)

VI. Monitoring the Different Body Systems

- A. Respiratory**
- B Cardiovascular**
- C. Neurological**
- D. Genito-Urinary**
- E. Sensory and Neuromuscular Function**
- F. Metabolic State**

VII. Indication for Invasive Monitor

- A. Direct Arterial Pressure**
- B. Central Venous Pressure**
- C. Pulmonary Arterial Pressure**
- D. Urinary Output Monitor**
- E. Body Temperature**
- F. Intracranial Pressure**
- G. Serial Blood Gases, Hemoglobin/Hematocrit, Serum
Electrolytes, Coagulation, Blood Sugar**
- H. Transesophageal Two-Dimensional Echocardiography**

VII. Monitoring for Specific Injuries

- A. Head Injury**
 - 1. Glasgow Coma Scale**
 - 2. Doppler Monitor**
 - 3. Intracranial Pressure Monitor**

- 4. Electroencephalogram
- B. Spinal Cord Injury
 - 1. Somatosensory Evoked Potential
- C. Burn Injury
 - 1. Temperature Monitoring
 - 2. Volume Status, Blood Losses
 - 3. CarboxyHemoglobin Levels
- D. Pregnant Trauma Patient
 - 1. Doppler Fetal Heart Monitor
 - 2. Tocodynamometer

IX. Other Monitors and Advanced Technology

- A. Transtracheal Doppler Device
- B. Cerebral Function Monitor
- C. Density Modular Spectral Array
- D. Spectral Edge Frequency
- E. Power Spectrum Analysis

PLENARY SESSION 6:

**Perioperative Anesthetic Management of Patients with
Injured Organ Systems: Part I**

Moderator: Yves Lambert, MD

Perioperative Anesthetic Management of Burn Trauma

Bruce F. Cullen, MD

Smoke Inhalation

Yves Lambert, MD

Perioperative Anesthetic Management of Orthopedic Trauma

Andrew D. Rosenberg, MD

Discussion

PERIOPERATIVE ANESTHETIC MANAGEMENT OF BURN TRAUMA

Bruce F. Cullen, M.D.

I. Introduction

A. Classification

- 1. Superficial**
- 2. Partial Thickness**
- 3. Full Thickness**

B. Epidemiology

II. Initial Management

A. Airway Management

B. Smoke Inhalation

- 1. Carbon Monoxide**

III. Pathophysiology of Burns

A. Cardiovascular Effects

- 1. Fluid Therapy**

B. Hypermetabolism

C. Thermoregulation and Heat loss

D. Renal Effects

E. Gastrointestinal Effects

F. Immunosuppression

G. Miscellaneous Other Effects

IV. Anesthetic Considerations for Burn Excision and Grafting

- A. Preoperative Medications**
- B. Advance Preparation**
 - 1. Personnel**
 - 2. Monitoring**
- C. Securing an Airway**
- D. Ventilation**
- E. Fluid and Blood Therapy**
- F. Temperature Regulation**
- G. Anesthetic Agents and Techniques**
 - 1. Opioids**
 - 2. Volatile Agents**
 - 3. Epinephrine**
- H. Muscle Relaxants**
 - 1. Succinylcholine**
 - 2. Non-Depolarizing Relaxants**
- I. Postoperative Care**
 - 1. Analgesia**

IV. Electrical Burns

SMOKE INHALATION

Yves Lambert, M.D.

I. Introduction

- A. Definition of Smoke in Fire Accidents**
- B. Definition of Smoke Inhalation Injury (SII)**
- C. History of SII**

II. Epidemiology

- A. Circumstances**
- B. Number of Victims**
- C. Socioeconomic Aspects**
- D. Incidence of SII in Fire Victims**
- E. Mortality Rate in the Field**
- F. In Hospital Mortality Rate**

III. Toxic Products of Combustion

- A. Products Released During a Fire**
- B. Experimental Data vs. Actual Home Fire**
- C. Low Inspired Oxygen Fraction**
- D. Duration of Exposure to Smoke**

IV. SII: Systemic Poisoning

- A. Main Poisons**
 - 1. Carbon Monoxide**
 - 2. Cyanide**

3. Methemoglobinemia

4. Other

B. Their Toxic Effects

V. SII: Pulmonary Injury

A. Heat Injury

B. Chemical Injury

1. Pathophysiology

2. Location of Injury

a. Solubility of Gases

b. Size of Inhaled Particules

VI. SII: Diagnosis

A. History of Fire

B. Cutaneous Signs

C. Respiratory Signs

D. Neurologic Signs

E. Blood Gases and Chest Radiology

F. Carbon Monoxide and Cyanide Blood Level

G. Other Diagnostic Tests

H. Fiberoptic Bronchoscopy

VII. Treatment of SII

A. Oxygen

1. Correction of Hypoxia

2. Antidote Effect

3. Hyperbaric Oxygenation (HBO)

- B. Specific Antidotes**
- C. Fiberoptic Bronchoscopy and Pulmonary Toilet**
- D. Other Treatments**

VIII. Conclusions

PERIOPERATIVE ANESTHETIC MANAGEMENT OF ORTHOPEDIC TRAUMA

Andrew D. Rosenberg, M.D.

I. Pelvic injuries

A. Mechanism of Injury

B. Associated Problems

1. Hemorrhage
2. Pelvic Organ Injuries
3. Coagulopathies
4. Pelvic Thrombosis

C. Case Approach

1. General vs. Regional or Combination
2. Monitoring ("A"-line, Central Monitoring)
3. SSEP
4. Cell Saver
5. Urine Output
6. Role of MAST
7. Postoperative Pain Management

II. Hip Fractures

A. Dislocations and Fracture Dislocations

B. Proximal Femoral Fractures

1. Site of Injury
 - a. Subcapital
 - b. Transcervical
 - c. Trochanteric

- d. Subtrochanteric
- 2. Patient Characteristics
 - a. Age
 - b. Concurrent Diseases
 - c. Changes in the Elderly Pharmacology and Physiology of Aging
- 3. Case Approach
 - a. Perioperative Checklist
 - b. Preview of Systems
 - c. Role of Anesthetic Technique
 - d. Timing of Surgery
 - e. Perioperative Management
 - 1. Hypotension
 - 2. Hypertension
 - 3. Cement
 - 4. Pulmonary Embolism Considerations
 - f. Postoperative Management

III. Thromboembolism

- A. Incidence
- B. Prevention
 - 1. Medication
 - 2. Lower Limb Compression Devices

IV. Compartment Syndrome

V. Long Bone Fractures

A. Stabilization

B. Fat Embolism

- 1. Incidence**
- 2. Pathophysiology**
- 3. Presentation**
- 4. Diagnosis and Treatment**

VI. Cervical Spine

A. Incidence

B. Anatomy

C. Injuries

D. Principles of Management

- 1. Stabilization**
- 2. Securing an Airway**
- 3. Maintaining Adequate Ventilation**
 - a. C5 and Above vs. C5 and Below**
 - b. PAO₂, CO₂**
- 4. Maintaining Adequate BP**
- 5. Medications (Steroids, Succinylcholine)**
- 6. Spinal Shock**
- 7. Respiratory Considerations:**
- 8. Circulation:**
 - a. Autonomic Hyperflexia**
- 9. Gastrointestinal**
- 10. Case Approach**

- a. Fiberoptic
- b. SSEP
- c. Monitoring
- d. Agents
- e. Positioning
- f. Postoperative Considerations

VII. Thoracic Spine

A.

- 1. General Considerations
- 2. Associated Injuries

B. Case Approach (See Cervical Spine Injuries)

PLENARY SESSION 7:

**Perioperative Anesthetic Management of Patients with
Injured Organ Systems: Part II**

Moderator: Leland H. Hanowell, MD

Fat Embolism as a Complication of Trauma

Anne J. Sutcliffe, BSc, MB ChB, FFARCS, ARPS

Perioperative Anesthetic Management of Obstetric Trauma

Robin L. Prentice-Berkseth, MD

**Perioperative Anesthetic Management of
Thoracoabdominal Trauma**

Leland H. Hanowell, MD

Discussion

FAT EMBOLISM SYNDROME

Anne J. Sutcliffe, FFARCS

I. Fat Embolism or Fat Embolism Syndrome (F.E.S.)

II. Etiology of Fat Embolism Syndrome

- A. Long Bone Fracture**
- B. Pelvic Fracture**
- C. Joint Replacement**
- D. Bone Marrow Transplant**
- E. Liposuction**
- F. Intralipid Infusion**
- G. Chronic Pancreatitis**
- H. Sickle Cell Anemia**
- I. Diabetes Mellitus**

III. Incidence of Fat Embolism Syndrome

- A. 0.5-30%**
- B. Common in Second and Third Decades of Life (Can be a Complication of Child Abuse)**

IV. Onset of Fat Embolism Syndrome

- A. Usually 24-72 Hours Post Injury**
- B. Immediate Postoperative Period**
- C. Failure to Recover From Anesthesia**

V. Differential Diagnosis

- A. Sepsis**
- B. Delirium Tremens**
- C. Intracranial Hematoma**
- D. Pulmonary Embolism**
- E. Hypovolemia**

VI. Clinical Findings (mild F.E.S.)

- A. Tachypnoea**
- B. Dyspnea**
- C. Cyanosis**
- D. Headache**
- E. Irritability**
- F. Confusion**
- G. Tachycardia**
- H. Pyrexia**
- I. Petechial Rash**

VII. Clinical Findings (Severe F.E.S.)

- A. Frank Pulmonary Edema**
- B. Convulsions/Coma**
- C. ECG Showing Right Heart Strain**
- D. Pyrexia**
- E. Petechial Hemorrhage**
- F. Jaundice**
- G. Renal Impairment**

VIII. Laboratory Findings

- A. Snow Storm CXR
- B. Reduced PaO₂
- C. Anemia
- D. Thrombocytopenia
- E. Hypocalcaemia
- F. Alveolar Cell Fat
- G. (Elevated Serum lipase)
- H. (Globules of Fat in Sputum and Urine)

IX. Fat Embolism Index

	Score
Petechiae	5
Diffuse alveolar infiltrates	4
PaO ₂ < 9.3kPa	3
Confusion	1
Fever > 38 C	1
Heart Rate > 120/min	1
Respiratory Rate > 30/min	1

X. Pathophysiology of Fat Embolism Syndrome

- A. Mechanical Theory
 - 1. Torn Blood Vessels
 - 2. Marrow Pressure Greater Than Venous Pressure
 - 3. Release of Free Fat
- B. Biochemical Theories

1. Obstructive
2. Toxic

XI. Treatment of Fat Embolism Syndrome: Established

- A. Oxygen
- B. Mechanical Ventilation
- C. Restoration of Circulating Blood Volume
- D. Splintage of Fractures
- E. Analgesia
- F. ? Control of ICP

XIII. Treatment of Fat Embolism Syndrome: Unproven

- A. Steroids
- B. Alcohol
- C. Heparin
- D. Dextran 40
- E. Aprotinin

XIV. Prevention of Fat Embolism Syndrome

- A. Oxygen for 48 Hours Post Injury
- B. Meticulous Fluid Balance
- C. Immobilization of fractures
- D. Drainage of Fracture Hematoma

PERIOPERATIVE ANESTHETIC MANAGEMENT OF OBSTETRIC TRAUMA

Robin L. Prentice-Berkseth, M.D.

I. Introduction

- A. Causes of Maternal Mortality**
- B. Influences of Changing Socioeconomics**
- C. Types of Trauma in Pregnant Women**
 - 1. Blunt**
 - 2. Penetrating**
 - 3. Burns**

II. Maternal Physiologic Changes

- A. Respiratory Changes**
- B. Cardiovascular Changes**
- C. Coagulation System**
- D. Hepatic Changes**
- E. Gastrointestinal Changes**
- F. Renal Changes**
- G. CNS Changes**

III. Resuscitation and Preoperative Preparation

- A. Field Intervention**
 - 1. ABC's as per ATLS**
 - a. Supplemental O2**
 - b. Special Airway Considerations**
 - 2. Transport**

- a. Left Lateral Tilt
 - b. Reevaluation of Vital Signs
 - c. Use of MAST Trousers
- B. Intra Hospital - Definitive Management
 - 1. ABC's as per ATLS with Special Considerations
 - a. Airway - Late Pregnancy Edema
 - b. Breathing - Pregnant vs. Non-Pregnant ABC's
 - c. Circulation
 - i. Supine Hypotensive Syndrome
 - ii. Effect of Physiologic Anemia, Change in Blood Volume
 - 2. Primary Assessment
 - 3. Secondary Assessment
 - a. Obstetric Consultation
 - i. Fetal Assessment
 - ii. Placental Assessment
 - iii. Uterine Assessment
 - b. "Standard" ATLS Secondary Assessment

IV. Anesthetic Management

- A. With C-Section
 - 1. Stable Patient
 - a. C-Section Alone
 - b. Additional Peripheral Procedures
 - 2. Unstable Patient - Concurrent Thoracic or Abdominal Procedure

B. Without C-Section

1. After Fetal Demise

- a. Any Technique Appropriate**
- b. Induction - Vaginal Delivery when Stable Post-op**

2. With Viable Fetus

- a. Concerns**
 - i. Asphyxia**
 - ii. Teratogenesis**
 - iii. Preterm Labor**
- b. Fetal Monitoring**
- c. Consider Regional Anesthesia**

V. Fetal Physiology - Neonatal Resuscitation

A. Fetal Physiology

- 1. Fetal Heart Rate**
- 2. Utero-Placental Circulation**

B. Neonatal Resuscitation

- 1. Neonatal Advanced Life Support**
- 2. ABC's**
- 3. Medications/Fluid**

VI. Teratology

A. Pregnancy Risk Categories

B. Drugs Used in Management of Trauma Victim

VII. Special Considerations

A. Post-Perimortem C-Section

1. Best done within 5 minutes of Maternal Death
2. Should be Attempted after 28 Weeks Gestation
3. Personnel for Neonatal Resuscitation must be available

B. Maintaining In Utero Pregnancy with Maternal Brain Death

1. Maintain Optimal Maternal Homeostasis
2. Periodic Fetal Testing
3. Neonatal Consultant

C. Substance Abuse

VIII. Summary

**ENHANCED MODALITIES OF VENTILATION FOR THE CRITICALLY ILL TRAUMA
VICTIM**

Leland H. Hanowell, M.D.

I. Pathophysiology

- A. Reduced Compliance of the Lung or Chest Wall**

**II. Requirements for Ventilation Under Circumstances of Reduced
Pulmonary Compliance**

- A. Constant Flow Despite Elevated Airway Pressure**
- B. Consequences of Inadequate Ventilator Mechanics**

III. Ventilation Modes

- A. Pressure Controlled Ventilation**
- B. Inverse Ratio Ventilation**
- C. Differential Lung Ventilation**

IV. Adjuncts to Reduce Work of Breathing

- A. Pressure Support Ventilation**
- B. Flow-by Systems**

V. Newer Modalities of Ventilation

- A. Volume Support**
- B. Pressure Regulated Volume Control**

SIMULTANEOUS SESSION I.

Difficult Airway Management for the Trauma Patient

This session will begin with representative case presentations of controversial issues such as shotgun wounds of the face, facial fractures, the "wired jaw," spinal ankylosis, laryngeal injury, penetrating neck wounds, tracheostomies, intrathoracic airway trauma, and the use of special management techniques. Audience participation is emphasized in the form of questions and answers and commentary dialogue. The second portion of the session will feature "hands-on" skill stations such as fiberoptic intubation procedures, protection of cervical spine injury, and performing cricothyroidotomy:

*Moderators-in-Chief: Kenneth J. Abrams, MD
Elizabeth C. Behringer, MD*

Introduction and Welcome

Case Discussions

Bullard Laryngoscope, Cricothyroidotomy
Kenneth J. Abrams, MD

Augustine Guide, Nasal Intubation
Charles R. Barton, CRNA, MEd

Fiberoptic Intubation
Leland H. Hanowell, MD

Aspiration Prophylaxis/Combitube
Adolph H. Giesecke, MD

Difficult Airway/Intubation Alert
Lynette J. Mark, MD

Magnetic Intubation
Vijayalakshmi U. Patil, MD

Lung Separation Techniques:
Double Lumen Tubes, Univent Tube
Elizabeth C. Behringer, MD

Laryngeal Mask Airway
*Anne J. Sutcliffe, BSc, MB, ChB,
FFARCS, ARPS*

BAAM, MIAT, Cricoid Pressure
John K. Stene, MD, PhD

Airway Management Skill Stations

Bullard Laryngoscope, Cricothyroidotomy
Kenneth J. Abrams, MD

Lung Separation Techniques:
Double Lumen Tubes, Univent Tube
Elizabeth C. Behringer, MD

Augustine Guide, Nasal Intubation
Charles R. Barton, CRNA, MEd

Fiberoptic Intubation
Leland H. Hanowell, MD

Aspiration Prophylaxis/Combitube
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Vijayalakshmi U. Patil, MD

BAAM, MIAT, Cricoid Pressure
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Laryngeal Mask Airway
*Anne J. Sutcliffe, BSc, MB, ChB,
FFARCS, ARPS*

BULLARD LARYNGOSCOPY FOR TRAUMA AIRWAY MANAGEMENT
Kenneth J. Abrams, M.D.

A. Case History

A 32-year-old male was involved in a diving accident. On presentation to the resuscitation area, he was noted to be agitated and disoriented, Glasgow Coma Scale 9. There was notable maxillofacial injuries.

He arrived fully immobilized with a hard cervical collar in place. Initial vital signs were BP 90/50 mmHg, pulse 54 BPM, respiratory rate 26 RPM.

Endotracheal intubation was accomplished with the Bullard laryngoscope.

B. Guidelines for Discussion

1. What is the Bullard laryngoscope?
2. Indications for use of the Bullard laryngoscope.
3. Endotracheal intubation technique with the Bullard laryngoscope.
4. Limitations and difficulty using the Bullard laryngoscope.

C. References

1. Abrams KJ, Desai N, Katsnelson T. Bullard laryngoscopy for trauma airway management in suspected cervical spine injuries. *Anesth Analg.* 1992;74:619-23.
2. Shigematsu T, Mayazawa N, Yorozu T. Nasotracheal intubation using Bullard Laryngoscope. *Can J Anaesth.* 1991;38(6):798.
3. Saunders PR, Giesecke AH. Clinical Assessment of the adult Bullard laryngoscope. *Can J Anaesth.* 1989;36(S):118-119.
4. Bjoraker DG. The Bullard intubating laryngoscopes. *Anesth Rev.* 1990;17:64-70.
5. Dyson A, Harris J, Bhatia K. Rapidity and accuracy of tracheal intubation in a mannequin: Comparison of the fiberoptic with the Bullard laryngoscope. *Br J Anaesth.* 1990;65:268-70.
6. Gorback MS. Management of the challenging airway with the Bullard laryngoscope. *J Clin Anesth.* 1991;3:473-77.

THE AUGUSTINE GUIDE FOR RAPID "BLIND" OROTRACHEAL INTUBATION
OF THE TRAUMA PATIENT

Charles R. Barton, CRNA, M.ED

A. Case History

A 27 year old male was involved in a motor vehicular accident. He was not wearing a seat belt and was thrown clear of the automobile. On presentation to the trauma admission area, he was awake and alert with a Glasgow Coma Scale of 15. He had an open fracture of his left tibia and fibula. He complained of neck pain and abdominal pain upon arrival.

The patient arrived on a long spine board with full immobilization including a hard cervical collar. Initial vital signs were BP 85/50 torr, pulse 100 BPM, respirations labored at 30 per minute. Diagnostic peritoneal lavage revealed grossly bloody fluid and abdominal laparotomy was ordered. Cervical radiographs revealed a fracture of C-5 with no displacement. No neural deficits were present.

The patient received fluid resuscitation with good response following infusion of crystalloids and 1000ml hetastarch. Mild sedation/analgesia was accomplished with midazolam and nalbuphine. The trachea was blindly intubated with use of the Augustine Guide while the patient's head was maintained in neutral alignment without rotation, extension or flexion of the neck. Following a normal neurological evaluation, anesthesia was induced with appropriate doses of thiopental, fentanyl and vecuronium. Anesthesia was maintained with isoflurane, O₂ and air, and incremental doses of fentanyl and vecuronium as needed.

B. Guidelines for Discussion

1. What is the Augustine Guide? What are the indications for its use?
2. Endotracheal intubation technique with the Augustine Guide.
3. Methods for dealing with possible limitations/difficulties using the Augustine Guide during initial learning curve.

C. References

1. Augustine Guide Instruction Manual: Augustine Medical, Inc. 10393 West 70th Street, Eden Prairie, MN 55344 1991.
2. Grande CM, Barton CR, Stene JK. Appropriate techniques for airway management of emergency patients with suspected spinal cord injuries. *Anesth Analg.* 1988;67:714.* *(This reference gives general principles for trauma airway management which are met when the Augustine Guide is utilized as recommended.)*

FIBEROPTIC INTUBATION AND BRONCHOSCOPY: AN OVERVIEW
by Leland H. Hanowell, M.D.

- 1) **Technical aspects of bronchoscopy**
- 2) **Bronchial anatomy review**
- 3) **Case discussions**
- 4) **Position statement**

NOTE: This case will be discussed during Dr. Hanowell's skill station session.

**A MALPOSITIONED DOUBLE LUMEN ENDOTRACHEAL TUBE IN A PATIENT WITH
AN UNSUSPECTED DIFFICULT AIRWAY**

Leland H. Hanowell, M.D.

A. Case History

A 63 year old male requires a right upper lobectomy for tumor excision. A left double lumen tube (DLET) is requested for access during the procedure. The patient appears to have a normal airway on preoperative evaluation. The DLET is placed with difficulty on the third attempt; the vocal cords cannot be visualized during direct laryngoscopy. The bronchoscope is inserted in the tracheal lumen of the DLET and there is evidence of tube malposition (a slide will demonstrate the bronchoscopic appearance). The DLET is successfully positioned (to be discussed). Postoperatively the patient is grossly edematous, yet requires replacement of the DLET with a single lumen endotracheal tube (SLET).

B. Guidelines for Discussion

1. When fiberoptic inspection indicates tube malposition or a DLET must be replaced with a SLET, what are options to manage the difficult airway or postoperative edema, respectively?
 - a. How does one recognize malposition of the DLET?
 - b. How does one manage DLET malposition and correct it?
 - c. How can a DLET be safely replaced with a SLET in instances of difficult airway or postoperative edema?
 - d. What airway adjuncts are appropriate during tube replacement?
2. Is fiberoptic placement of a single lumen tube with an endobronchial blocker a more appropriate option for the patient with a difficult airway or anticipated postoperative edema?

C. References

1. American Thoracic Society, Position Paper. Guidelines for fiberoptic bronchoscopy in adults. Am Rev Respir Dis 1987;136(4):1066.
2. Ehrenwerth J. Proper positioning of a double-lumen endobronchial tube can only be accomplished with endoscopy (Pro position). J Cardiothor Anesth 1988;2:101-104.
3. Gayes JM. the Univent tube is the best technique for providing one-lung ventilation. Pro Position (see also Con Position in same reference). J Cardiothor Vasc Anesth 1993;7:103-107.
4. Kirkpatrick MB, Smith JR, Hoffman PJ, Middleton RM. Bronchoscope damage and repair costs: Results of a regional postal survey. Resp Care 1992;37:1256-1259.
5. Reed AP. Preparation of the patient for awake flexible fiberoptic bronchoscopy. Chest 1992;101:2440-253.

ASPIRATION PROPHYLAXIS/COMBITUBE

A.H. Giesecke, M.D.

ASPIRATION PROPHYLAXIS

A. Case History

A 45 year old day laborer, who was 6 ft 3 in (187cm) tall and weighed 320 lbs (145 kg) was working with a metal lathe and sustained a penetrating wound of the right eye. The steel splinter could be clearly seen in the anterior chamber through the cornea. Part of the iris was herniating from the entry wound at the corneal scleral junction. The accident happened right after lunch. The anesthesiologist, Dr. A elected to do a modified rapid sequence induction using the split dose "priming principle" with vecuronium. During the recommended 5 minute waiting period after the "priming dose" of 1.5 mg vecuronium the patient became very agitated and combative. Fearing that this huge man might hurt himself or someone else, Dr. A gave thiopental 500 mg IV followed by vecuronium 13 mg. As the patient lost consciousness he regurgitated and aspirated massive amounts of undigested food.

B. Guidelines for Discussion

1. Who is "at risk" from aspiration?
2. Could general anesthesia have been avoided?
3. Should the stomach have been emptied with a sump tube before induction? With metaclopramide?
4. Should succinylcholine have been used?
5. What is the "priming principle"?
6. Should the Combitube or the LMA be used here?
7. Should a pre-induction antacid have been used?
8. Later the patient wanted the anesthesiologist to pay for his \$30,000 bill for intensive care. Should Dr. A pay the bill?

C. References

1. Hilley MD, Giesecke AH. The patient with a full stomach. *Seminars in Anesthesia*. 1990;9:204-10.
2. Vender JS. Pulmonary aspiration in Cane RD, Shapiro BA: *Case Studies in Critical Medicine*. Yearbook Medical Publishers, Chicago, 1989.

COMBITUBE

A. Case History

A 33 year old motorcyclist collided with the side of a truck, splintering the side panels. The patients neck was impaled with a large wooden splinter entering at the left angle of the mandible, traversing the pharynx, and penetrating into the right maxillary sinus just below the floor of the orbit. During the initial evaluation the patient became unresponsive and apneic. An attempted laryngoscopy revealed a "wall of wood" preventing entry of the scope into the oropharynx. A Combitube was inserted.

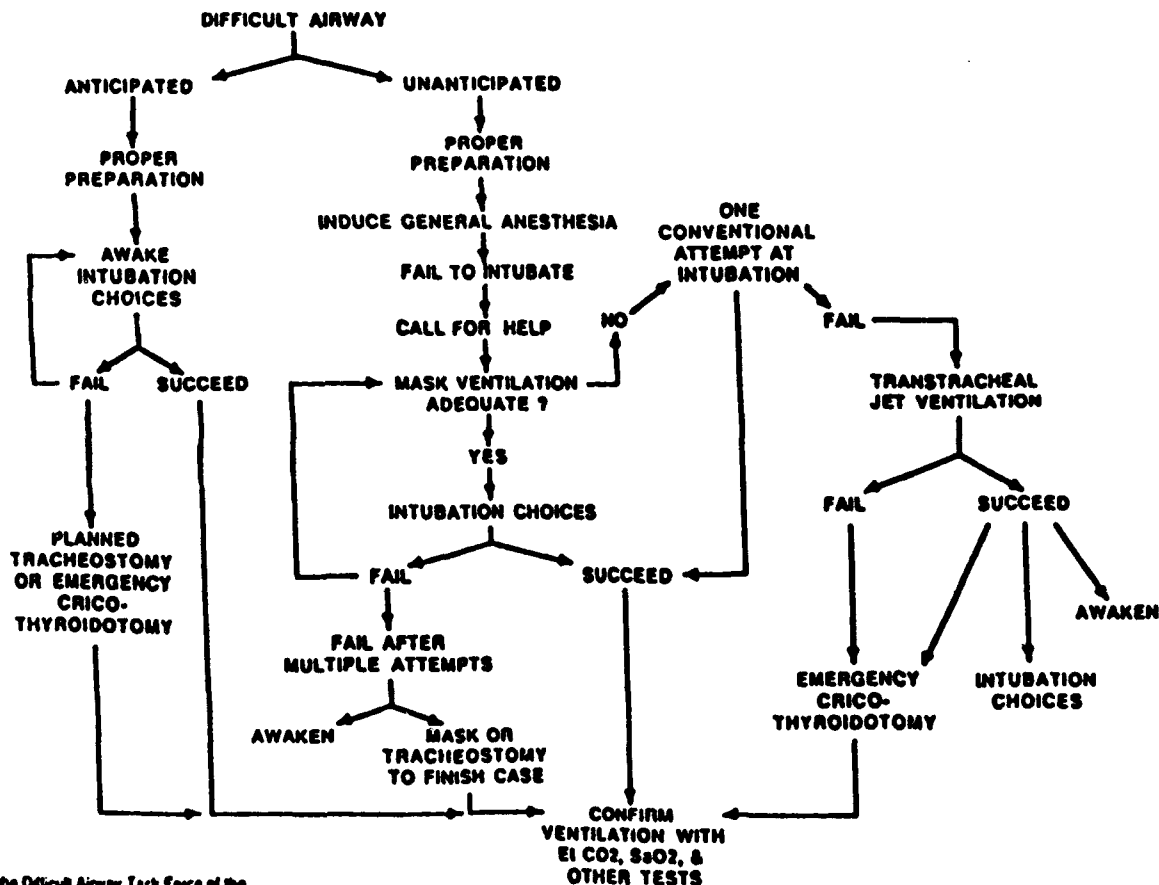
B. Guidelines for Discussion

1. Contrast the structure of the EOA, Combitube, EGTA, PTLA, LMA?
2. Contrast tracheal vs esophageal placement of EOZ, EGTA, PTLA, Combitube?
3. What are the indications for tracheostomy in penetrating neck trauma?
4. Describe the indications and complications of trans cricothyroid jet ventilation?
5. Lead us through the "Difficult Airway Algorithm" in this case.

C. References

1. Emergency Cardiac Care Committee: American Heart Association Guidelines for cardiopulmonary resuscitation and cardiac care. JAMA. 1992;268:2172-2302.
2. Eichinger S, Schreiber W, Heinz T, et al. Airway management in a case of neck impalement, use of the esophageal tracheal combitube airway. Brit J Anaesth. 1992;68:534-5.
3. Ward ME. A new look at the breath of life. Brit J Anaesth. 1992;69:339-40.
4. Frass M, Frenzer R, Rauscha F, et al. Evaluation of esophageal tracheal combitube in cardiopulmonary resuscitation. Critical Care Medicine. 1986;15:609-11.
5. Practice Guidelines for Management of the Difficult Airway: A Report by the American Society of Anesthesiologists Task Force on Management of the Difficult Airway. Anesthesiology. 1993;78:597.
6. Benumof JL. Management of the difficult airway. Anesthesiology. 1991;75:1087-1110.

DIFFICULT AIRWAY ALGORITHM



Developed by the Difficult Airway Task Force of the
Committee on Patient Safety and Risk Management.

"DIFFICULT AIRWAY/INTUBATION ALERT" IN THE EMERGENCY ROOM

Lynette Mark, M.D.

A. Case History

A 60 year old male, 2 months S/P aortic valve replacement and composite graft repair of the ascending aorta, is involved in a motor vehicle accident and sustains blunt chest trauma from the steering wheel. On admission, he complains of moderate chest pain, is tachypneic but maintaining his airway.

His wife relates his medication history to include Coumadin. Additionally, she comments that the anesthesiologist for his heart surgery told them that he was a "difficult intubation" and that they had chipped a tooth.

On physical exam, his sternum is tender to palpation and moderately mobile. He is in increasing respiratory difficulty, tachypneic, and has decreased breath sounds over his left chest. His SaO₂ is 94% on face mask O₂. Airway exam reveals good oral excursion, small chip to incisor tooth, and Mallampati Class II pharyngeal view.

He has just had his cervical spine "cleared" with portable x-ray, and is being scheduled to go to the cardiac catheterization laboratory to evaluate his cardiac status.

B. Guidelines for Discussion

1. What is the overall incidence of difficult airway/intubation?
 - a. What are considerations with pre-operative evaluation?
 - b. What are limitations of "predictors" for airway difficulty?
2. What is the relative worth of documentation of prior airway difficulties in the Trauma Centers/Emergency Departments?
 - a. Does documentation get retrieved? Should it?
 - b. If the above patient was wearing a Medic Alert bracelet and wallet card, would the information influence subsequent management? What information would you like to have immediate access to?
3. Which techniques would be appropriate in the management of this patient?
4. Which techniques from above are readily available?
 - a. In the Trauma Center/Emergency Department?
 - b. In the catheterization laboratory?
5. How would you manage this patient's airway?

C. References

1. Caplan RA, Posner K, Ward RJ, Cheney W. Adverse respiratory events in anesthesia: a closed claim analysis. *Anesthesiology* 1990; 72:828-33.
2. Wilson ME, John R. Problems with the Mallampati sign. *Anaesthesia* 1990; 45:486-7.
3. Temple WJ. Medic Alert Foundation International. Turlock, CA. *ASA Newsletter* 1980; 44:3-4.
4. Mark LJ, Beattie C, et al. The Difficult Airway: Mechanisms for Effective Dissemination of Critical Information. *J of Clin Anesth* 1992; 4:247-251.
5. Mark LJ. Medic Alert: Difficult Airway/Intubation. *ITACCS Newsletter* 1992; 3:12-13.

MAGNETIC INTUBATION

Vijayalakshmi U. Patil, M.D.

A. Case History

A 70 year old female scheduled for lumbar laminectomy at L₄-L₅ level. No significant medical history nor any concerned physical findings in the patient were found. Examination of the patient's airway revealed a full set of teeth, the uvula was unable to be seen when the mouth was fully opened, with a protruding tongue in the sitting position. The space between the lower part of the mandible to thyroid notch was less than 6 cm long when the patient was lying flat on the bed with head in full extension. After the induction of general anesthesia and muscle relaxant, multiple attempts at endotracheal intubation with direct laryngoscope and fiberoptic endoscope were both unsuccessful. The patient was ventilated without any difficulty by mask throughout this period. An Otolaryngologist was consulted, was also unable to visualize the larynx, and attempts at intubation were unsuccessful. The Surgeon and Anesthesiologist jointly decided to postpone the surgery. The patient returned to surgery after two days. Under general anesthesia and muscle relaxant, under direct laryngoscopy with Mac #3 blade, the patient trachea was intubated with magnet, ferrous stylet and two part intubation catheter, successfully on the first attempt without any difficulty.

B. Guidelines for Discussion

1. What is magnetic intubation?
2. When magnetic intubation is applicable.
3. Contraindications and complications of magnetic intubation.

C. References

1. Benumof JL. Management of the difficult adult airway. *Anesthesiology*. 1991;75:1087-1110.
2. Brain ALJ. The laryngeal mask - a new concept in airway management. *Br J Anaesth*. 1983;55:801.
3. Dogra S, Falconer R, Latto IP. Successful difficult intubation: tracheal tube placement over a gum-elastic bougie. *Anaesthesia*. 1990;45:774-776.
4. Latto IP, Rosen M. Management of difficult intubation, difficulties in tracheal intubation. London, Bailliere Tindall, 1985;99-141.
5. Ovassapian A. Fiberoptic airway endoscopy in anesthesia and critical care, New York, Raven Press, 1990.
6. Patil VU, Stehling LC, Zauder HL. Techniques of endotracheal intubation, fiberoptic endoscopy in anesthesia. Chicago, Year Book Medical Publishers, Inc. 1983, p79.
7. Rayburn RL. Light wand intubation. *Anaesthesia*. 1979;34:667.
8. Robelen GT, Shulman MS. Use of the lighted stylet for difficult intubations in adult patients (abstract). *Anesthesiology*. 1989;71:A439.

TECHNIQUES OF LUNG ISOLATION IN THE MANAGEMENT OF THORACIC TRAUMA PATIENTS

Elizabeth C. Behringer, M.D.

A. Case History

A 20 year old previously healthy white male is admitted to the Emergency Room (ER) thirty minutes following a high speed skateboard accident. The patient lost control of his skateboard and collided with a large elm tree. At the scene, he was alert and responsive, complaining of shortness of breath and severe left chest pain. His left arm was grossly deformed. Initial vital signs: BP 100/60, P:110 reg, R:30 labored. 100% face mask O₂ was administered by paramedics.

He arrives in the ER secured to a long spine board, hard cervical collar in place with two 14 gauge antecubital intravenous lines running Lactated Ringers solution. Vital signs on arrival in the ER: BP 70/palp, P:150 reg, RR:40 labored, O₂ saturation 92%. C X R reveals a large left hemopneumothorax. His entire left lung field is opacified. In addition, he has a comminuted left humeral fracture and multiple rib fractures. Lateral CSpine film is clear through the seventh cervical vertebrae. The thoracic surgeons place a chest tube which drains 1500cc of bright red blood. The patient is scheduled for an emergency left exploratory thoracotomy.

B. Guidelines for Discussion

1. Indications for One-lung ventilation
2. Isolation Techniques
 - a. Bronchial blockers
 - i. Univent tube
 - b. Single-lumen endobronchial tubes
 - c. Double-lumen endobronchial tubes
3. Complications of lung isolation techniques
4. Lung isolation techniques in trauma patients

C. References

1. Wilson, RS. Endobronchial Intubation in Thoracic Anesthesia. Second edition. Kaplan JA (ed) Churchill Livingstone, New York, 1991, pp 371-388.
2. Gottlieb LS, Hillberg R. Endobronchial tamponade therapy for intractable hemoptysis. Chest. 1991;67:482.
3. Gourin A, Garzon AA. Control of hemorrhage in emergency pulmonary resection for massive hemoptysis. Chest. 1975;68:120.
4. Garzon AA, Cerruti MM, Golding ME. Exsanguinating hemoptysis. J Thorac Cardiovasc Surg. 1982;84:829.
5. Inoue H, Shohtsu A, Ogawa J, et al. Endotracheal tube with movable blocker to prevent aspiration of intratracheal bleeding. Ann Thorac Surg. 1984;37:497.
6. Kamaya H, Krishna PR. New endotracheal tube (Univent Tube) for selective blockade of one lung. Anesthesiology. 1985;63:342.
7. Herenstein R, Russo JR, Moonka N, Capan LV. Management of one-lung anesthesia in an anticoagulated patient. Anesth Analg. 1988;67:1120.
8. Heiser M, Steinberg JJ, Macvaugh H et al. Bronchial rupture, a complication of use of the Robertshaw double-lumen tube. Anesthesiology. 1979;51:88.
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THE LARYNGEAL MASK AIRWAY IN THE EMERGENCY ROOM

Dr. Anne J. Sutcliffe BSc FFARCS ARPS

A. Case History

A 34 year old female pedestrian was hit by a car and sustained a severe head injury and facial lacerations but no other injuries. On admission her Glasgow Coma Score was 7, she was unable to maintain her own airway and was bleeding profusely from the posterior nasal space. There was a need to protect her airway. Endotracheal intubation was potentially difficult due to bleeding and the possible co-existence of a cervical spine injury.

B. Guidelines for Discussion

1. Is the laryngeal mask airway (LMA) a suitable alternative to endotracheal intubation?
 - a. What is a LMA?
 - b. What conditions are required for placement?
 - c. Does the LMA guarantee a clear airway?
 - d. Does the LMA protect against pulmonary inhalation?
 - e. What does placement of an LMA do to intracranial pressure?
2. How can the LMA be used as an adjunct to endotracheal intubation?
3. Is there a place for the LMA in pre-hospital care?

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BAAM, MIAT, AND CRICOID PRESSURE

John K. Stene, M.D., Ph.D.

A. Case History

19 year old male unbelted driver was thrown from his car after striking a tree approximately 0100 on Saturday morning. Patient is comatose at the scene with agonal respiration. Carotid pulse is barely palpable and rapid. Blood pressure is unobtainable by cuff. Patient has a Glasgow Coma Scale of 3/15 and right pupil is much larger than left. Patient's breath smells of ethanol and several empty alcoholic beverage containers litter his car. He has suffered facial trauma with a markedly deformed and hemorrhaging nose.

B. Guidelines for Discussion

1. What is the best method for the first responders to secure definitive airway control?
2. This patient has a serious head injury that would benefit from increased pulmonary carbon dioxide excretion and oxygen uptake. Furthermore, he has a potential cervical spine fracture and spinal cord injury and mid-face/nasal trauma that contraindicates nasal intubation. Finally, he is in profound shock and will have very low carbon dioxide production, very low $P_A\text{CO}_2$, and very low $P_{\text{ET}}\text{CO}_2$.
 - a. How can they protect his cervical spine from excessive motion during intubation?
 - b. What is the best method to protect patient from gastric regurgitation and aspiration of stomach contents?
 - c. What is the best method of maintaining oxygen and carbon dioxide gas exchange in the lungs to optimize oxygen delivery to injured brain?
 - d. Finally, how are the first providers to determine correct intratracheal endotracheal tube placement in patient with low cardiac output and low pulmonary CO_2 delivery (also low $P_A\text{CO}_2$)?

C. References

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SIMULTANEOUS SESSION II.

Trauma Anesthesia for Disasters

This session will begin with short didactic presentations of basic principles of anesthesia under extreme conditions. Then, beginning with an explanation of the "rules of engagement," members of the audience will be assigned various roles that they will assume during the "simulations." The simulations will include combined mass casualty/disaster/military situations and will focus on evaluation of individual and team performance under stressful conditions.

Moderator-in-Chief: Vladimir Kvetan, MD

Panelists: Yoel Donchin, MD

J. Alexander Hunter, MBBS, MRCP, FRCAnaes

Nachshon Knoler, MD

Marzio G. Mezzetti, MD, PhD

T. Michael Moles, MBBS, FFARCS, DTMH

Michael Olds, PA-C, NREMT-P

Michael J. A. Parr, MBBS, MRCP, FRCAnaes

PART 1: DIDACTIC PRESENTATIONS

**Overview of Disaster Epidemiology and Response
(ECF 8 and ECF 9)**

Vladimir Kvetan, MD

**Modifications of Standard Trauma Anesthesia/Critical Care
Protocols for Disasters**

Marzio G. Mezzetti, MD, PhD

**Civilian Mass Casualty Incidents: Implications for
Anesthesia/Critical Care Services**

T. Michael Moles, MBBS, FFARCS, DTMH

**Clinical Trauma Anesthesia/Critical Care Specialist
Approach and Use of Non-Anesthesia Personnel**

Yoel Donchin, MD

PART 2: SIMULATION

Yoel Donchin, MD, and Panelists

INTRODUCTION TO TACC AND DISASTER MEDICINE

V. Kvetan, M.D.

- 1. Demographics of disasters**
- 2. Disaster response**
 - a.) local**
 - b.) regional**
 - c.) national**
 - d.) international**
- 3. Governmental response**
 - a.) civilian**
 - b.) military**
- 4. Disasters as an academic exercise**
 - a.) syndrome management**
 - b.) disaster management**

**MODIFICATIONS OF STANDARD TRAUMA ANESTHESIA/CRITICAL CARE
PROTOCOLS FOR DISASTERS**

Marzio Mezzetti, M.D., Ph.D.

- I. Differences Between Conventional Trauma Anesthesia/Critical Care and Disaster Trauma Anesthesia/Critical Care**
- II. Absolute relative Disparity Between Need of Care and Medical Resources**
- III. Need for Revised Protocols:**
 - A. Modification of Protocols for Airway Maintenance**
 - B. Protocols for Vascular Access**
 - C. Protocols for Fluid Administration**
 - D. Protocols for Analgesia on the Scene**
 - E. Protocols for Early Minimal Stabilization**
 - F. Protocols for Anesthesia on the Scene**
 - G. Protocols for Anesthesia in a Field Hospital**

H. Protocols for Post-Operative Control

II. Anesthesia Team for Disaster Procedure

III. Nursing in OR/CCU in Disaster Areas

IV. Summary/Conclusions

FLASH, BANG and IMPACT
Bomb Casualties and the TACC Specialist

Michael MOLES
Reader in Anaesthetics, University of Hong Kong

1.0 OPPORTUNITY

Terrorism has come to America. Perhaps it is timely to review experience of terrorist bombing incidents in the UK (Birmingham, Tower of London, Baltic Exchange) Northern Ireland (Abercorn, Inniskillen), France (Paris), Italy (Bologna) and the Middle East (Beriut), from the point of view of the TACC Specialist.

2.0 BALLISTICS AND PATHOPHYSIOLOGY OF EXPOSITION INJURIES

2.1 Wound ballistics is excellently reviewed in the literature Refs

2.2 Usually only a small percentage of casualties sustain severe injuries, but these may be multisystem and complex (e.g. high and low velocity penetrating, blast, burn, smoke inhalation injuries).

2.3 Blast, Tympanic, Airways, Alveolar, Pneumothorax, avulsion injuries.

2.4 Missiles

2.4.1 Primary : Shrapnel large or small, high or low velocity

2.4.2 Secondary: glass/wood; may be non-radiolucent.

2.5 Thermal

2.5.1 Increasingly, weapons incorporate VHT thermal agents.
 Secondary fire is common.

2.5.2 Face, hands, upper and occasionally lower airways.

2.6 Smoke

2.6.1 Carbonaceous or toxic

2.7 Implications

2.7.1 Casualties may be deaf or incommunicado

2.7.2 Identification may be difficult

2.7.3 Some injuries present with covert onset, esp. blast of lungs

2.7.4 There is therefore need for disciplined diagnostic protocols and a HIGH INDEX OF SUSPICION esp in casualties scheduled for early intervention.

3.0 INCIDENT LOGISTICS

3.1 LOCATION is usually Metropolitan, occasionally transportation; therefore;

3.1.1 may be in close proximity to HOSPITALS.

3.1.2 Disaster Alert may not be generated

- 3.1.3 Hospital must have AUTONOMOUS ALERT CAPABILITY
- 3.1.4 Casualty profile may be multilingual/cultural etc.

3.2 COMMUNICATIONS

- 3.2.1 ALERT may be bypassed
- 3.2.2 INCIDENT SITE radio-silence may be mandated (electronically actuated detonators for secondary weapons.
- 3.2.3 Casualty estimates (number and severity) may be non-existent or inaccurate
- 3.2.4 Confounded by
 - 3.2.4.1 Terrorist activity
 - 1. false alarms
 - 2. multiple weapons
 - 3. attack on communication nodes
 - 3.2.4.2 Overload
 - 1. Casualties
 - 2. Press
 - 3. Public
 - 4. Diplomatic services
- 3.2.5 CASUALTY MARSHALLING/TRACKING SYSTEM
Must have beaurocratic requirements reduced to MINIMUM

4.0 CASUALTY LOGISTICS

- 4.1 Casualty influx, because of proximity, may by-pass ALERT and/or TRIAGE.
- 4.2 Casualty influx may present independent of prior TRIAGE and with ambulant casualties first (REVERSED TRIAGE).
- 4.3 Therefore
 - 4.3.1 Plan must provide for
 - 4.3.1 very rapid SET-UP (CONTROL & E.R.)
 - 4.3.2 very rapid TRIAGE
 - 4.3.3 very rapid CASUALTY STREAMING
 - 4.3.4 very rapid CASUALTY BUFFERING

5.0 PLANNING

It will be assumed:

- 5.1 that general Disaster Plans are in position, appropriately profiled and practiced.
- 5.2 that the plan makes provision for a PHASED RESPONSE
 - 5.2.1 Phase 1, AUTOMATIC; the Rapid Response Component which facilitates near-immediate reaction to sudden casualty load; this will involve TACC personnel.

5.2.2 Phase 2, DISCRETIONARY; the Controlled Response Component which facilitates matching of extended reaction to overall casualty load; this will also involve TACC personnel.

5.3 that within such general plans provision is made for TACC Services to function as a Tactical Module.

5.4 that TACC personnel are routinely involved in resuscitation (pre- and in-hospital) as well as TACC.

6.0 THE TACC MODULE

6.1 Assumes

6.1.1 Overall Medical/Nursing/Logistics joint CONTROL with TACC services as a functioning tactical MODULE.

6.1.2 Phased Response.

6.2 PHASE 1 AUTOMATIC Very rapid response; < 12 minutes

TACC HOSPITAL

6.2.1 Control	TACC personnel/location
6.2.2 RESUSCITATION TEAM(S) (SHOCK/TRAUMA)	ditto Commander
6.2.3 CRITICAL CARE TEAM	ditto "
6.2.4 OT/OR TEAM	ditto "
6.2.5 TRANSPORT TEAM (if not Level 1)	ditto "

PROTOCOLS (ACTIONCARDS) should be established and reviewed

PRE-HOSPITAL

6.2.6 MOBILE MEDICAL TEAM(S)	ditto Commander
Surgeon/TACC sp/paramedic(s)	
TASK: Analgesia/Anaesth for EXTRICATION	
Resuscitation	

Appropriately EQUIPPED & TRAINED (ATLS & SPECIAL TRAINED)

6.3 PHASE 2 DISCRETIONARY

TACC HOSPITAL

6.3.1 ANAESTHESIA
6.3.2 ANALGESIA
6.3.3 CRITICAL CARE
6.3.4 TRANSPORT

7.0 WORKLOAD

7.1 Frequently referred to in Surgical literature, rather less in TACC mode
notable exceptions: Coad et al
Coppell et al
Cotev et al

7.2 Initial workload

Anecdotal reports indicate generally a manageable initial workload although procedures often are prolonged and/or multidisciplinary. Initial intervention should be kept to a minimum. Severely injured (often trapped) casualties arrive later.

7.3 Extended workload

Coad et al

Bomb/blast/missile/burn injuries demand extended care and, often, multiple surgical procedures.

This places heavy load on TACC personnel for up to four weeks following an incident. Considerate planning and personnel management at directorate level can contribute to impact amelioration.

7.4 Recovery

Provision for rapid recovery to "GO" STATUS should be incorporated into Disaster Plans.

Terrorists seek the "oxygen of publicity" by campaigns of repeated bomb attacks and these may occur surprisingly close together; examples have occurred: Paris and more recently in Bombay where there were 30 substantial weapons detonated in a period of 3 days, with over 1000 casualties.

8.0 FAMILIARIZATION AND SPECIAL TRAINING

8.1 General

TACC personnel should receive, as an integral part of training, exposure to work under adverse conditions and with minimal equipment. It is entirely feasible to do this at minimum cost/time expense and with no adverse hazard to staff or patients.

TACC Societies should stimulate and support such training particularly in Level 1 TC's and/or provide simulation in collaboration with appropriate Armed Forces or Emergency Services, who should also have responsibility for security/safety instruction.

RECOMMENDED TEXT

GRANDE CM, STENE JK

Mechanisms of Injury: Etiologies of Trauma pp 37-63

In: Trauma Anaesthesia STENE JK, GRANDE CM Eds Williams and Wilkins
Baltimore 1991

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See next page

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SIMULTANEOUS SESSION III.

Trauma Anesthesia Research: Scientific Free Papers: Part II

During this session participants will give brief oral presentations using slides of scientific material related to trauma anesthesia and critical care. An award will be given for the best presentation. Presentations will be chosen on the basis of scientific merit and content.

Moderator-in-Chief: Enrico M. Camporesi, MD

Moderators: Pierre A. Carli, MD

Levon M. Capan, MD

Bruce F. Cullen, MD

Adolph H. Giesecke, MD

Colin F. Mackenzie, MD

Ronald G. Pearl, MD, PhD

SCIENTIFIC FREE PAPERS: PART II

Saturday, May 22, 1993

Comparison of Perioperative Events in Patients with Trauma, Non Trauma
Emergency and Elective Surgery

Effects of Flumazenil on the Isolated Rabbit Myocardium

Use of a Large Bore Cricothyroidotomy Catheter for Emergency Airway Management

Use of the Lower Extremity for Noninvasive Blood Pressure Monitoring in Pregnant
Patient at Term

Intensive Care Unit Experience in the Developing World Comparison of 6%
Dextran-70 and 7.5% NACL on Myocardial Contractility in Rabbits

Comparison of Direct Effects of Vecuronium and Pancuronium on Myocardial
Contractility

Cervical Spine Movement During Orotracheal Intubation: Comparison of the
Belscope and Macintosh Blades

Peroperative Autotransfusion in Emergency Surgery for Spine Trauma

Changes in the Initial Distribution Volume of Glucose Following Acute Hemorrhage
in Dogs

Systemic Gas Embolism in Pulmonary Contusion Diagnosed by Transesophageal
Echocardiography

Physostigmine in Recovery from Military Anaesthesia

Prehospital Management of Severe Maxillo-facial Injury

Hyperventilation Versus Sodium Bicarbonate for the Treatment Acidosis in Canine
Hemorrhagic Shock

An Intubation Suction Stylet

Prediction of Mortality in Elderly Patients Using ASA Classification Following Blunt
Trauma

Role of Anaesthesiologist in Management of Mass Casualties Following Violence: A
Recent Experience

The Inspiratory Work of Breathing Across Transtracheal Cannulae

Peroperative Autotransfusion for Spinal Trauma In Emergency

Prevention of Thromboembolism After Spinal Cord Injury Using Low-Molecular-
Weight Heparin

COMPARISON OF PERIOPERATIVE EVENTS IN PATIENTS WITH TRAUMA, NON TRAUMA EMERGENCY AND ELECTIVE SURGERY

J.B.Shah, M.D., J.S. Plotkin, M.D., B. Tyler, RN, F. Kane, Ph.D., Departments of Anesthesiology, Medical College of Virginia, Richmond, Virginia 23298

Introduction: In an attempt to identify prevalent intraoperative and postoperative events, as well as demographics, Trauma(group I) and Non Trauma Emergency(group II) patients were compared to all Elective PACU patients (group III) for the year 1992. Trauma patients accounted for 426 and all Non Trauma Emergency patients accounted for 724. Specific categories were examined in numbers of patients and percentage comparisons were drawn within and between groups.

Events

Ages between 1 day and 20 years
Ages between 21 and 40 years
Ages greater than 60
ASA status I & II
ASA status III, IV, and V
Regional, MAC, Anesthetics
General Anesthetics
IV Fluids <1000 ml
IV Fluids 1001 - 3000 ml
IV Fluids >3001 ml
Blood/Blood Product
Intraop invasive monitoring
Intraop metabolic or renal
PACU reintubation, arrest, death
Respiratory Intervention
Desaturation in PACU
Unanticipated ICU admission
Temperature >35C
Hypothermia < 35C
PACU stay >4 hours
New chest x-ray finding
PACU invasive monitoring
Hypertension with aggressive Rx
Hypotension with fluid challenge

Group I		Group II		Group III	
Trauma	426	Non Trauma	724	Elective	9899
Patients	%	Patients	%	Patients	%
83	19.48	123	16.99	1759	17.77
238	55.87	296	40.88	3513	35.49
27	6.34	126	17.40	2057	20.78
336	78.87	451	62.29	7372	74.47
90	21.13	274	37.85	2853	28.82
15	3.52	51	7.04	1106	11.17
400	93.90	639	88.26	7968	80.49
89	20.89	335	46.27	4448	44.93
204	47.89	297	41.02	4335	43.79
130	30.52	88	12.15	1370	13.84
144	33.80	182	25.14	1670	16.87
148	34.74	161	22.24	1844	18.63
40	9.39	50	6.91	733	7.40
5	1.17	8	1.10	32	.32
14	3.29	18	2.49	165	1.67
253	59.39	340	46.96	3653	36.90
4	.94	9	1.24	72	.73
20	4.69	30	4.14	176	1.78
16	3.76	21	2.90	335	3.38
75	17.61	74	10.22	778	7.86
29	6.81	26	3.59	261	2.64
15	3.52	17	2.35	78	0.79
17	3.99	17	2.35	233	2.35
9	2.11	24	3.31	166	1.68

Discussion: While all groups reveal a predominance of patients age 21-40, group II patients are three times more likely than group I patients to be age 60 or greater. Further, all three groups show a preponderance of ASA II patients receiving general anesthetics. It is common practice to administer one to three litres crystalloid in all three groups, but group I has a higher percentage receiving more than three litres. While groups I and II were more likely to receive blood and blood products, one-third of all trauma patients required blood and invasive monitoring. In spite of aggressive respiratory intervention more than half the trauma victims and almost half the group II patients desaturated in PACU, requiring supplemental oxygen. New chest x-ray findings in the PACU, which were more common in group I patients, may reflect missed or developing pathology. Trauma patients, as expected, were more likely to suffer fatal events in the PACU. In this series, trauma patients did not suffer temperature alteration possibly due to an early aggressive team approach, but were more likely to have a prolonged PACU stay, indirectly reflecting cardio-respiratory instability.

The limitations of this study are it's retrospective nature, absence of trauma score inclusion and statistical analysis, dependency on accurate reporting of data, and lack of inclusion of intraoperative deaths or patients that went directly to the ICU.

In conclusion, trauma patients are more likely to be age 21-40, ASA II, receive general anesthetics, require increased amounts of fluids as well as blood and blood products, have an increased incidence of complications in the PACU, mainly respiratory in origin, with a prevalence of fatal events in PACU.

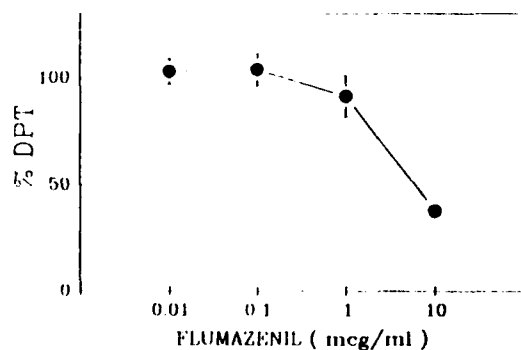
EFFECTS OF FLUMAZENIL ON THE ISOLATED RABBIT MYOCARDIUM

T. S. Lee, Y. Xie, X. Hou. Department of Anesthesiology, Harbor-UCLA Medical Center, Torrance, CA.

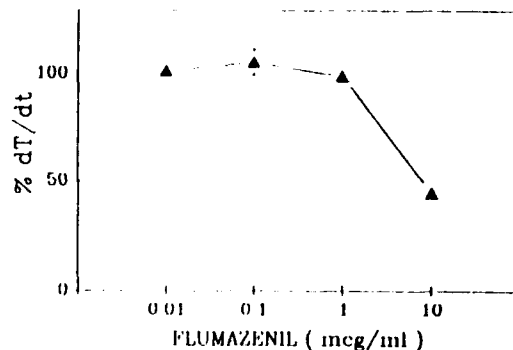
Benzodiazepines, commonly used in critical care areas, are known to have myocardial depression effects. Flumazenil, an imidazobenzodiazepine derivative, can antagonize the actions of benzodiazepines on the central nervous system. It is not known if flumazenil also antagonizes myocardial depression induced by benzodiazepine. The study is to investigate the direct effects of flumazenil on isolated myocardial septa in rabbits.

Six New Zealand white rabbits, weighing 2-3 kg, were anesthetized with 45 mg/kg i.v. pentobarbital. The heart was immediately removed. The first septal perforator of the left coronary artery was cannulated and perfused with warmed (37°C.) oxygenated modified Krebs-Ringer Bicarbonate buffer (KRB) solution at 1 ml/gm/min. The septum was then dissected out and suspended from a Grass FTO3 tension transducer. The other two corners were fixed with tension by opposing clamps through which a 5-volt/5 msec electrical stimulation was given from a Grass stimulator at 1.6 Hz. The peak developed tension (PDT), the maximal acceleration ($\pm dT/dt$), time to peak tension (TPT), and time to 1/2 tension relaxation ($RT_{1/2}$) were recorded. After reaching fully stabilized contractions for at least 30 min, perfusion of flumazenil diluted in KRB solution was started with different concentrations (0.01, 0.1, 1, 10 μ g/ml), respectively. Each dosage was given for 5 min and the plain oxygenated KRB solution was perfused in between as the control. The PDT, dT/dt , TPT, and $RT_{1/2}$ were calculated as % of control values. The results were analyzed with paired t-test and summarized in the figures below.

FLUMAZENIL ON MYOCARDIAL CONTRACTILITY



FLUMAZENIL ON MYOCARDIAL CONTRACTILITY



Flumazenil causes negative inotropic effects which are dose-dependent. Whether it is due to flumazenil itself or its preservatives requires further studies.

USE OF A LARGE BORE CRICOTHYROIDOTOMY CATHETER FOR EMERGENCY AIRWAY MANAGEMENT.

V.U. Patil*, G.M. Atlas*, and P. Woo**. *Dept. of Anesthesiology and **Dept. of Otolaryngology. State University of New York Health Science Center at Syracuse, NY 13210.

Conventional 14 gauge IV angiocatheters have been used for emergency airway management to provide jet ventilation. We evaluated a large bore (9 French I.D. with 13 French O.D. and length 6 cm) catheter (LBC) for emergency airway management. The device allows for rapid insertion percutaneously, with a built in dilator and 19 gauge needle, and can be used with either a jet ventilator, standard Mapleson D circuit, or ambu bag. The reinforced polyvinylchloride catheter, with a built in curve, minimizes kinking and allows easy passage of a standard guide wire to simplify retrograde intubation.

After approval of the animal ethics committee, 9 mongrel dogs were given general anesthesia. Blood gas measurements, transtracheal pressures, and plethysmographic data were recorded. The results of the blood gas data are shown in the table. The LBC, when used with either a Mapleson D or jet, was not significantly different from a 14 g cricothyroidotomy catheter, used with a jet ventilator, in its ability to oxygenate or ventilate for 15 minutes. The LBC did offer improved ventilation ($P < 0.05$) when used with a jet when compared to its use with a Mapleson D circuit.

	LBC with Mapleson D	LBC with jet	14 gauge IV with jet
PaO ₂	435.0 ± 165.3	503.3 ± 139.0	349.1 ± 131.2
PaCO ₂	56.2 ± 12.5*	39.2 ± 14.1*	45.5 ± 19.1

*mean ± standard deviation (mmHg), * $P < 0.05$

In addition, the LBC was easily maneuvered from a caudad to cephalad direction allowing passage of a guide wire to facilitate retrograde intubation of the trachea with a standard endotracheal tube.

In conclusion, the large bore cricothyroidotomy catheter offers an advantage over a traditional 14 gauge angiocatheter in its improved mechanical structure, ease of insertion, and ability to be used with either a jet ventilator, Mapleson D or ambu bag. This system, when used with either an ambu bag or Mapleson D, should be readily applicable for emergency applications in humans when jet ventilation may not be immediately available.

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USE OF THE LOWER EXTREMITY FOR NONINVASIVE BLOOD PRESSURE MONITORING IN PREGNANT PATIENT AT TERM.

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INTRODUCTION: Trauma is fast becoming the leading cause of mortality in women of childbearing age(1) accounting for 30 deaths/100,000 in this population.(2) Of all pregnant patients suffering traumatic injury, the greatest percentage are near term.(3) When confronted with a near term patient suffering traumatic injury, the anesthesiologist may have to resort to unconventional sites for hemodynamic monitoring. Accurate monitoring of vital signs is of utmost importance. The upper extremities remain the most common access for noninvasive blood pressure (BP) monitoring. The arms may, however not always be available as in cases where the upper extremities are traumatized. Additionally, the presence of a blood pressure cuff frequently inflating and deflating may prevent the efficient use of any intravenous access in that arm by inhibiting rapid flow of resuscitative fluids. We evaluated the reliability of noninvasive lower leg blood pressure (LBP) measurements in comparison to arm blood pressure (ABP) measurements in term pregnant patients. Additionally, we studied the effect epidural anesthesia may have on any difference.

METHODS: Fifty-five ASA Class I parturients at term had right arm and right ankle blood pressure obtained simultaneously in triplicate using DATASCOPE ACCUTORR 3 before and after epidural administration of medications. The same monitors were used on all the study patients. All measurements were made after left uterine displacement was initiated and in the absence of uterine contractions. After the initial data were collected, epidural analgesia was instituted with a combination of bupivacaine 0.125% and fentanyl 1.3 mcg/cc at rate of 8-12 cc/hr. Blood pressure measurements were then obtained as before. Statistical analysis of the difference between arm and ankle blood pressures (systolic, mean, diastolic) and the comparison of magnitude of difference between the blood pressures before and after initiation of epidural analgesia was accomplished using the pared Student's t- test and ANOVA with $p < 0.05$ as the level of statistical significance.

RESULTS: All ankle pressure values were higher than corresponding arm pressure (fig. 1) before and after epidural analgesia. The difference in magnitude ranged from 5.5 mm Hg for DBP to 20.5 mm Hg for SBP; it was consistent for all patients. Ankle to arm BP gradients for MBP were intermediate. (fig. 2) Epidural analgesia did not alter these gradients in a statistically significant fashion.

Fig. 1: Blood Pressure Measurements in Arm and Ankle Before and During Epidural Analgesia (Mean \pm SD)

Blood pressure (mmHg)	Arm (n=55)	Ankle (n=55)	p-value
Before Anesthesia:			
Mean	92.4 \pm 12.0	103.9 \pm 10.8	<0.0001
Systolic	126.5 \pm 14.4	147.0 \pm 15.0	<0.0001
Diastolic	74.4 \pm 9.10	79.9 \pm 9.21	<0.0001
After Anesthesia:			
Mean	83.5 \pm 10.1	92.7 \pm 10.4	<0.0001
Systolic	116.0 \pm 11.8	133.8 \pm 15.3	<0.0001
Diastolic	65.3 \pm 10.2	71.5 \pm 10.0	<0.0001

Fig. 2: Ankle - Arm Blood Pressure Gradient Before and During Epidural Analgesia (Mean \pm SD)

Gradient (Ankle/Arm)			
Blood pressure (mmHg)	Before Anesthesia (n=55)	After Anesthesia (n=55)	p-value
Mean	11.5 \pm 9.17	9.22 \pm 10.2	0.1799
Systolic	20.5 \pm 11.2	17.9 \pm 14.2	0.2522
Diastolic	5.55 \pm 8.08	6.18 \pm 10.3	0.6729

CONCLUSION:

1) We believe the ankle offers a reliable alternative for measuring BP noninvasively in pregnant patients at term with the understanding that any measurement taken in the ankle will be higher than simultaneous measurement taken from the arm. These differences will be greatest for SBP, least for DBP and intermediate for MBP. Any clinical decision regarding perfusion based on blood pressure measurements taken at the ankle must, therefore, take into account these differences.

2) Epidural analgesia does not affect the difference between arm and ankle blood pressures.

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INTENSIVE CARE UNIT EXPERIENCE IN THE DEVELOPING WORLD

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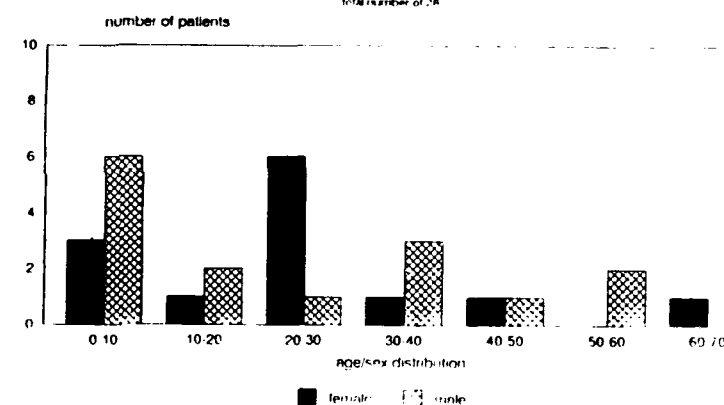
Kilimanjaro Christian Medical Centre is one of Tanzania's four tertiary referral hospitals. It has an I.C.U. with fourteen beds. We felt it would be of interest to present the patients admitted to this unit over one week in December 1992.

After Ethical Committee approval we noted the following information from each admission to the unit. Age, sex, diagnosis on admission, investigations done, drugs used in treatment and outcome. The simplest way to audit outcome was whether the patient died or was discharged from the unit.

Twenty-eight patients were admitted over the seven days. Their age, sex and diagnosis are illustrated at the bottom of the page. The investigations done were mainly haemoglobins, blood glucose, urea and electrolytes, malaria parasite slides and simple x-ray and ultrasound examinations. Treatments included saline soaks, physiotherapy and drug therapy. Nine patients died out of the total admitted approximately thirty three percent. Treatments were limited by the scarcity of trained staff and drugs. However the use of these antibiotics was haphazard. Cultures were not done though this service was available at K.C.M.C.

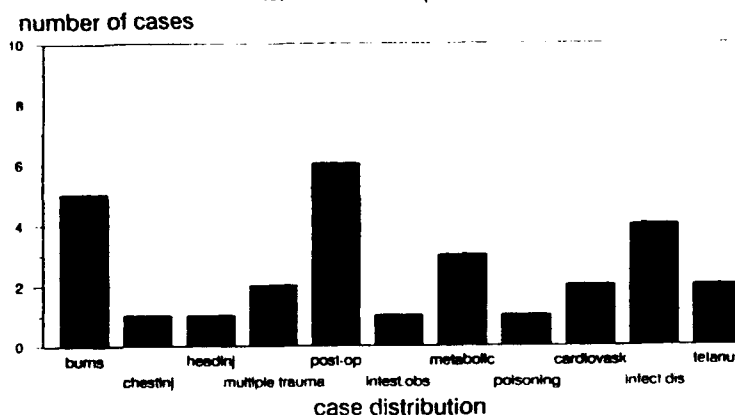
This I.C.U. is representative of those found in the developing world. The types of patients treated are similar to ours in the developed world except for a few particular to the area such as malaria and the case of poisoning which was due to organophorous compounds produced in a local insecticide factory recently transferred from Europe. The staff need training and at present K.C.M.C. is on the Overseas Teaching Programme of the A.S.A. a volunteer with I.C.U. experience would enhance patient care enormously and would help to foster links with units in the U.S. This is one of the avenues recommended to advance health care in the developing world.

Age Profile of Patients of the KCMC ICU
one week in december 1992
total number of 28



Moshi, Tanzania 1992
Smith/Matt

Case Profile of Patients in the ICU
total number of 28 patients



Moshi, Tanzania december 1992
Smith/Matt

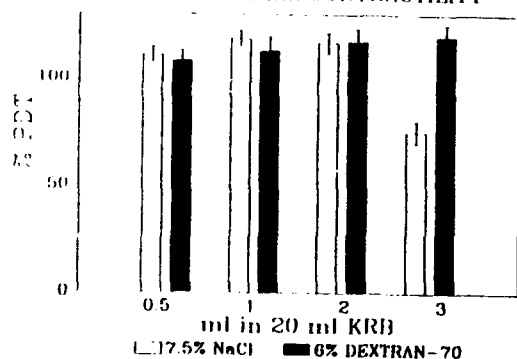
COMPARISON OF 6% DEXTRAN-70 AND 7.5% NaCl ON MYOCARDIAL CONTRACTILITY IN RABBITS

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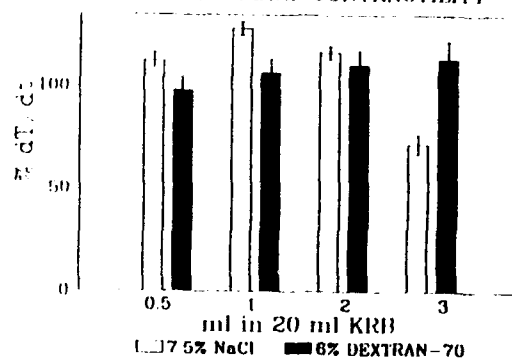
Combined use of hypertonic saline (7.5% NaCl) and hyperoncotic colloid (6% dextran-70) have been found to be useful in resuscitation of shock. However, their respective effects on myocardial contractility have not been well defined. This study was to investigate the direct effects of these two solutions on the isolated myocardial septa in rabbits.

Six New Zealand white rabbits were used. The heart was immediately removed after i.v. pentobarbital. The first septal perforator artery was cannulated and perfused with warmed (37°C.) oxygenated (bubbled with 95% O₂, 5% CO₂) Krebs-Ringer bicarbonate buffer (KRB) solution at a rate of 1 ml/gm/min. The septum was then dissected out and suspended from a Grass FT03 tension transducer. The other two corners of the septum were fixed by two opposing clamps through which a 5-volt/5 msec electrical stimulation was given at 1.5 Hz. Resting muscle tension was adjusted to 3-5 gm. Perfusion with 7.5% NaCl or 6% dextran-70 was then started at concentrations of 0.5, 1, 2, 3 ml/20 ml KRB. Each dosage was given for 5 min and plain oxygenated KRB solution was given in between as the control for 10 min. The peak developed tension (PDT) and the maximal acceleration (dT/dt) were recorded at the end of perfusion as % of control values. The results were analyzed statistically by Student's t-test for paired data and summarized in the figures below.

COMPARISON OF 7.5% NaCl AND 6% DEXTRAN-70 ON MYOCARDIAL CONTRACTILITY



COMPARISON OF 7.5% NaCl AND 6% DEXTRAN-70 ON MYOCARDIAL CONTRACTILITY



With direct coronary perfusion technique, 6% dextran-70 showed a dose-dependent positive inotropic effect. 7.5% NaCl, on the other hand, caused a dose-related biphasic response on myocardial contractility.

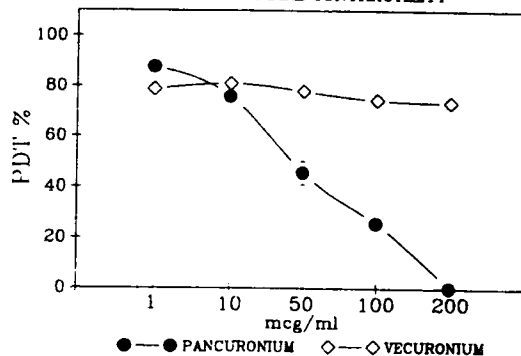
COMPARISON OF DIRECT EFFECTS OF VECURONIUM AND PANCURONIUM ON MYOCARDIAL CONTRACTILITY

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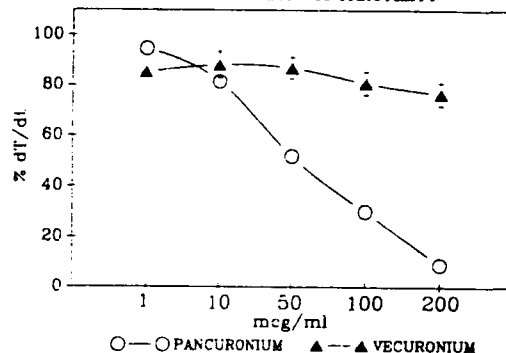
Clinically, pancuronium has been considered to have positive hemodynamic responses with increases in heart rate, cardiac output and blood pressure. Its inotropic effect, if any, is insignificant. On the other hand, vecuronium has been recognized as the muscle relaxant with most stable cardiovascular responses. This study is to investigate and compare the direct effects of these two agents on the myocardial contractility in the isolated rabbit myocardium.

Six New Zealand white rabbits were used. The heart was immediately removed after i.v. pentobarbital. The first septal perforator artery was cannulated and perfused with warmed (37°C.) oxygenated (bubbled with 95% O₂, 5% CO₂) Krebs-Ringer bicarbonate buffer (KRB) solution at a rate of 1 ml/gm/min. The septum was then dissected out and suspended from a Grass FTO3 tension transducer. The other two corners of the septum were fixed by two opposing clamps through which a 5-volt/5 msec electrical stimulation was given at 1.5 Hz. Resting muscle tension was adjusted to 3-5 gm. Perfusion with vecuronium or pancuronium was then started at concentrations of 50, 100, 150, 200 mcg/ml. Each dosage was given for 5 min and plain oxygenated KRB solution was given in between as the control for 10 min. The peak developed tension (PDT) and the maximal acceleration (dT/dt) were recorded at the end of perfusion as % of control values. The results were analyzed statistically by Student's t-test for paired data and summarized in the figures below.

THE COMPARISON BETWEEN PANCURONIUM AND VECURONIUM ON MYOCARDIAL CONTRACTILITY



THE COMPARISON BETWEEN PANCURONIUM AND VECURONIUM ON MYOCARDIAL CONTRACTILITY



Vecuronium, in contrast to general perception, does have a moderate negative inotropic effect which seems not to be dose-related. On the other hand, pancuronium causes a very significant dose-dependent myocardial depression, particularly at high doses.

CERVICAL SPINE MOVEMENT DURING OROTRACHEAL INTUBATION: COMPARISON OF THE BELSCOPE AND MACINTOSH BLADES

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Purpose of study: The Belscope laryngoscope blade is angulated and has a detachable prism.¹ The purpose of this study was to compare cervical spine movement during use of the Belscope blade and conventional Macintosh blade during orotracheal intubation.

Methods used: After IRB approval and informed patient consent, twenty male ASA I and II patients undergoing elective surgery were studied. Following induction of anesthesia and muscle relaxation, a neutral cross-table lateral cervical spine x-ray was taken with a portable radiograph machine from 48 inches at 70 KV and 32 or 40 MAS. Laryngoscopy was then performed using both the Belscope (prism attached) and Macintosh blades in a random order. On visualization of the vocal cords, a size 8.0 mm tracheal tube was inserted and the cervical spine x-ray was repeated. Correct placement of the tube was confirmed by end tidal-capnography. Movement of the cervical spine was evaluated by tracing bony land marks on each film. ΔC_{1-0} was the difference in distance between the inferior aspect of the spinous process of C_1 and the occiput, comparing the neutral and laryngoscopy films. $\Delta C_1 + C_5$ was the sum of the anterior-posterior displacements of the vertebral bodies of C_1 and C_5 .

Results: Two patients were excluded from the study because they could not be intubated using the Belscope blade despite visualization of the vocal cords. Of the remaining patients, 13 had Mallampati class I airways and 5 had class II airways. The times for intubation and the amount of cervical spine movement are shown in table 1.

Table 1.	<u>Macintosh</u>	<u>Belscope</u>
Median time to Intubation (s)(range)	12 (5-25)*	18 (8-50)
Median ΔC_{1-0} (mm)(range)	6.0 (1-13)	5.5 (0-13)
Median $\Delta C_1 + C_5$ (mm)(range)	5.3 (1-12)	5.0 (3-14)
Median $\Delta C_{1-0} + \Delta C_1 + C_5$ (mm)(range)	10.5 (3-20.5)	11.0 (5-22)

* Significant difference between groups ($P < 0.01$)

Intubation took significantly longer with Belscope blade. We were unable to demonstrate any difference in the amount of cervical spine movement comparing the Belscope and Macintosh blades.

Conclusion: In this patient population, we could not demonstrate a difference between the Belscope and Macintosh blades in terms of cervical spine movement. However, using the Belscope blade, intubation took longer and was unsuccessful in two patients. We would not recommend the routine use of the Belscope blade for patients with cervical spine injury, although its use for patients with difficult airways in this situation remains to be established.

Reference: 1. Bellhouse CP: Anesthesiology 1988;69:126-129.

PEROPERATIVE AUTOTRANSFUSION IN EMERGENCY SURGERY FOR SPINE TRAUMA

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Emergency surgery for spine trauma induces significant blood loss, requiring blood transfusion. Peroperative blood salvage is often the only technique which could be applied during emergency surgery for spine trauma, but it has never been assessed during this condition. Thus, we assessed the efficacy of peroperative autotransfusion during emergency surgery for spine trauma.

Patients and methods: We retrospectively analyzed 230 consecutives cases of emergency surgery for spine trauma (1989-92) admitted to a single level 1 Trauma Center. Patients who required perioperative (< 24 hrs) blood transfusion were included and divided into 2 groups : those who benefited from intraoperative autotransfusion (Cell-Saver^R, Haemonetics) and those who did not (Control). Anesthesia was usually induced with thiopental and maintained with nitrous oxide, isoflurane, and fentanyl, and muscle relaxation achieved with vecuronium. Surgery was performed in the prone position and included reduction, laminectomy, and fixation using plates and pedicle screws. Data are mean \pm SD.

Results: Among the 230 patients, 109 required blood transfusion : 65 were control and 44 were in the Cell-Saver group. There were no significant differences between the 2 groups for sex ratio, incidence of spinal cord injury (62 %), incidence of dorsolumbar (72%) versus cervical injury, and Injury Severity Score (24 ± 12), but significant differences in age (40 ± 18 vs 32 ± 13 yrs), duration of surgery (211 ± 93 vs 267 ± 87 min), crystalloid (2223 ± 968 vs 2669 ± 1186 ml) and colloid (1669 ± 1238 vs 2159 ± 1238 ml) administration were noted between Control and Cell-Saver Groups, respectively. In the Cell-Saver Group, homologous blood transfusion was significantly reduced (538 ± 952 vs 1173 ± 1183 ml, $p < 0.005$) as well as the number of patients who received homologous blood (45 vs 81 %, $p < 0.001$).

Conclusion: Peroperative autotransfusion using the Cell-Saver technique enables a significant reduction in homologous blood transfusion in emergency surgery for spine trauma.

CHANGES IN THE INITIAL DISTRIBUTION VOLUME OF GLUCOSE FOLLOWING ACUTE HEMORRHAGE IN DOGS

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Introduction: The question of over- or undertransfusion occurs frequently when the traumatized patient has reached a relatively stable hemodynamic state after resuscitation. Glucose itself appears in the blood physiologically and can be given repeatedly and safely in small amounts. The initial distribution volume of glucose [IDVG] is thought to consist of both plasma volume and extravascular space of vessel rich tissues. However, glucose metabolism after a glucose challenge may modify the glucose kinetics, and the IDVG may fail to reflect the fluid status in the body. The purpose of the present study was to calculate the IDVG before and after acute removal of blood, and to examine the hypothesis that the IDVG reflects blood or plasma volume deficits in hemorrhagic dogs.

Methods: Seven anesthetized mongrel dogs were used. An arterial line and a balloon-tip flow directed, thermodilution catheter were inserted. Glucose (0.1 g/kg) was administered through the proximal injectate port of the pulmonary catheter over 30 seconds. Serial arterial blood samples were obtained, immediately before and three, five and seven minutes after the glucose injection. Prior to the glucose administration, thermodilution cardiac output was measured with chilled normal saline solution. After the completion of blood sampling, acute hemorrhage (30ml/kg) was induced by blood withdrawal over 30 minutes. Thirty minutes after the completion of the hemorrhage, the measurement and blood sampling were performed as during the prehemorrhagic period. The IDVG was calculated using a one compartment model from the incremental plasma decay curve.

Results: The residual sums of squares for each IDVG curve were less than 1×10^{-3} , which was small enough to allow a one compartment model to be fit. The mean IDVG before acute hemorrhage were 124 ± 16 (SD) ml/kg. Each dog showed a decrease in the IDVG following acute hemorrhage, and the mean IDVG difference between before and after hemorrhage was 30 ± 10 ml/kg. A correlation was obtained between the IDVG and thermodilution cardiac output ($r=0.82$, $n=14$, $P<0.001$).

Conclusion: The present study demonstrated that the modification of glucose metabolism on the IDVG was negligible judged from a significant relationship between the IDVG and cardiac output, and that changes in the IDVG following acute hemorrhage were close to the amounts of blood withdrawn. These findings suggest that a decrease in the IDVG reflects deficits of either plasma volume or extravascular space of highly perfused tissues, and that glucose may have potential as an indicator to evaluate fluid volume status when glucose is used for calculating the IDVG.

SYSTEMIC GAS EMBOLISM IN PULMONARY CONTUSION DIAGNOSED BY TRANSESOPHAGEAL ECHOCARDIOGRAPHY

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Systemic gas embolism has been described following penetrating lung injury and acute respiratory distress syndrome but not in pulmonary contusion after blunt trauma. We observed 3 patients with systemic gas embolism following severe blunt thoracic trauma and pulmonary contusion, demonstrated by transesophageal echocardiography (TEE).

Case 1 : After a car accident, a 20 year old woman had severe thoracic trauma with bilateral pulmonary contusion and complete paraplegia related to D1-D2 vertebra luxation. During the first 4 hours of surgery, (decompressing laminectomy, reduction of the luxation, and stabilization using plate and pedicle screws) hemodynamic status was stable but surgical blood loss was important (8 homologous blood units and 5 autologous blood units). During surgical wound closure, the surgeon noted the presence of bubbles in the surgical field. Then, arterial blood pressure abruptly dropped, and cardiac arrest occurred. After 10 min of cardiopulmonary resuscitation (CPR), return to spontaneous circulation (ROSC) was obtained. TEE showed : 1) absence of hypovolemia; 2) severe hypokinesia of the right ventricle, septum, and anterior part of the left ventricle; 3) the presence of bubbles in the left ventricle and not in the right cavities ; these bubbles disappeared as mechanical ventilation was stopped during a brief period. Hemodynamic and ventilatory status improved under high frequency jet ventilation (HFJV) but brain death was diagnosed.

Case 2 : After a car accident a 49 year old man was discovered in cardiac arrest by the prehospital team. After CPR, ROSC was obtained within 10 min. The patient had thoracic trauma with severe pulmonary contusion. EKG revealed an elevation of ST-T segment from V1 to V4 and CK-MB increased, suggesting myocardial infarction. TEE showed akinesia of the anterior part of the ventricle, a left ventricular ejection fraction (LVEF) of 10 % and no hypovolemia. Under mechanical ventilation with PEEP (8 cmH₂O), bubbles were observed in the left cavities and disappeared during brief interruption of ventilation. Suppression of PEEP dramatically decrease the incidence of bubbles in the left cavities. Contrast administration showed a patent foramen ovale only with a PEEP greater than 20 cmH₂O. The patient required inotropic support with epinephrine, and HFJV was instituted. No more bubbles were seen under HFJV. However, brain death was diagnosed and resuscitation stopped.

Case 3 : After a fall from a height (10 m), a 19 year old woman had thoracic trauma with pulmonary contusion, a fracture of the D12 vertebra with paraplegia, and pelvic trauma. During surgery (decompression laminectomy, reduction of the fracture, and stabilization using plates and pedicle screws). Surgical blood loss was important (10 homologous blood units and 8 autologous blood units). During surgical wound closure, arterial blood pressure abruptly dropped and large depression of ST segment was observed on the cardioscope, rapidly followed by ventricular fibrillation. The patient was immediately placed on a supine position, CPR was started, and ROSC was obtained. TEE, showed : 1) the absence of hypovolemia ; 2) dilated left ventricle with a LVEF of 10% ; 3) bubbles in the left cavities. During the postoperative period the hemodynamic and the ventilatory status improved and a complete neurological recovery was observed.

Discussion : Systemic gas embolism can occur after severe pulmonary contusion and its incidence is probably underestimated. It can be aggravated during mechanical ventilation due to overdistension of the lung secondary to large tidal volume, resulting in an interstitial and alveolar edema and ruptured capillaries. Such events may happen during mechanical ventilation in patients with pulmonary contusion. Thus it should be recommended to reduce tidal volume, to avoid PEEP, and possibly to use high frequency jet ventilation in order to decrease the mean airway pressure.

PHYSOSTIGMINE IN RECOVERY FROM MILITARY ANAESTHESIA

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An intravenous anaesthetic technique has been described for use by the British army in the battlefield situation, using a ketamine, midazolam and alfentanil infusion (1). Rapid recovery is especially desirable in the battlefield to enable evacuation. Unfortunately, ketamine has an unpredictable recovery interval.

A study performed on 60 patients giving physostigmine on termination of anaesthesia for cervical dilatation and curettage failed to demonstrate any difference in recovery interval between this group and those given placebo. However these patients had all been premedicated with papaveretum and hyoscine for very short operative procedures (2). We performed a study on unpremedicated patients, under standardised conditions, to observe the effects of physostigmine on the speed and quality of recovery from ketamine, midazolam and alfentanil anaesthesia.

Twenty eight ASA I, unpremedicated male patients undergoing minor orthopaedic procedures were included in the study. Half were allocated to receive physostigmine 25µg/kg on termination of the procedure along with glycopyrrolate 5µg/kg to prevent the peripheral anticholinesterase effects of the physostigmine. The other half received a similar volume of 0.9% saline. In both groups anaesthesia was maintained according to the regimen described above (1) although propofol was substituted for isoflurane via infusion in order to standardise the technique and convert it to total intravenous for the spontaneously breathing patient. All patients breathed throughout via a laryngeal mask and on termination of anaesthesia were administered either physostigmine and glycopyrrolate or 0.9% saline by the first anaesthetist. A second anaesthetist, blind to the nature of the substance administered, assessed recovery using Steward's scoring method (3).

There were no significant differences between the two groups with regard to physical characteristics, duration of procedure, total dose of propofol or total dose of the ketamine, midazolam, alfentanil mixture administered. However, there was a significant difference between the two groups with regard to recovery times.

Recovery Time (minutes)	Physostigmine Group	Non-Physostigmine Group
Mean	15.8*	33.7
Median	14.5*	30.0
Range	7 - 36	8 - 68

* $p < 0.001$ (Analysis by the Wilcoxon Rank Sum test, significant when $p < 0.05$)
No patient suffered any adverse reaction to the physostigmine / glycopyrrolate mixture.

From these results we can conclude that the recovery of basic reflex functions following ketamine, midazolam anaesthesia is far more rapid if reversed at termination with a physostigmine / glycopyrrolate mixture.

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PREHOSPITAL MANAGEMENT OF SEVERE MAXILLO-FACIAL INJURY

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STUDY OBJECTIVES: In patients sustaining injuries to the maxillo-facial area, several factors may lead to imminent life-threatening situations: i.e. obstruction of upper airway, aspiration, severe blood loss and additional injuries, that have not been diagnosed, or have been underestimated. The objective of this study is, to identify these additional (either missed or underestimated) injuries and the consequences for prehospital treatment.

DESIGN: Retrospective evaluation of 2201 cases of maxillo-facial injury, treated at our hospital from 01.03.1980 - 30.06.1991.

RESULTS: With reference to the maxillo-facial injury, 55% only involved the mid-face, whereas 38% were limited to mandible and 3% required treatment for a combination of both areas. Major causes: In the lead are traffic accidents (44%), followed by injuries from roughness, brutality (18%) and sport accidents (16%).

- * Additional life-threatening occurrences were experienced in 789 cases (35,8%) of the injuries, whereby the blunt head trauma, which involved extended unconsciousness, predominated.
- * 328 (14,9%) cases of chest trauma, respectively abdominal trauma occurred, whereby lung contusions were often associated with aspiration.
- * 512 (23,3%) cases involved fractures of the extremities.
- * 422 (19,2%) of the patients treated were, as defined by TSCHERNE, graded multiple trauma, that is almost every fifth patient.

CONCLUSION: The exact evaluation of the total injury pattern and the establishment of correct priorities is essential and the major prerequisite for adequate therapy. Of great importance is adequate fluid resuscitation and early endotracheal intubation. The contemplated transport to a specialized hospital must be critically examined, because often risky and unnecessary. The adequate hospital is the next closest trauma center.

HYPERVENTILATION VERSUS SODIUM BICARBONATE FOR THE TREATMENT OF ACIDOSIS IN CANINE HEMORRHAGIC SHOCK

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Hemorrhagic shock frequently leads to lactic acidosis and eventually profound metabolic acidosis. Therapeutic interventions include both sodium bicarbonate (Bic) and hyperventilation (Hyp) yet their respective efficacy has not been compared. The purpose of this study was to compare their influence on acid-base balance in arterial, mixed-venous, and jugular venous blood.

Six adult, splenectomized mongrel dogs were anesthetized, hemodynamically monitored, and mechanically ventilated to maintain the P_{aCO_2} at 35 to 45 mmHg, and P_{aO_2} at 100 to 150 mmHg. A catheter was passed to the jugular venous bulb via the external jugular vein. Hypotension was induced and maintained at a MAP of 35-40 mmHg by controlled hemorrhage and reinfusion. After approximately 2 hours of shock, when the arterial pH was less than 7.15 the dogs were randomized into 2 groups: 3 dogs received a volume of 8.4% Bic every 15 minutes for 1 hour in an effort to increase pH to 7.30. Three other dogs were incrementally hyperventilated every 15 minutes for 1 hour by first increasing the tidal volume and then increasing the respiratory rate in an effort to increase the pH to 7.30. A volume of 5.85% Sodium Chloride was given to control for the sodium load accompanying the Bic given to the first group of dogs. MAP was maintained at 40 mmHg throughout the study. Hemodynamic data was obtained 5 minutes after each intervention and metabolic data 10 minutes after each intervention, and analyzed by paired t-test.

(See Table) At baseline and after hemorrhage there were no significant differences between the groups. Therapeutic interventions resulted in a number of significant differences in arterial blood but only one significant difference in cerebral and mixed-venous blood (CO_2). There were no significant differences in cerebral oxygen delivery, extraction or lactate. Hemodynamics were similar in both groups.

In this model of canine hemorrhagic shock hyperventilation corrects arterial acidosis more efficiently than sodium bicarbonate. There was no indication of worsening cerebral ischemia.

Tx time (min)		15		30		45		60	
Tx grps		Hyp	Bic	Hyp	Bic	Hyp	Bic	Hyp	Bic
apH		7.30 ± .06*	7.2 ± .02	7.34 ± .05*	7.25 ± .03	7.37 ± .05*	7.23 ± .04	7.37 ± .06	7.27 ± .04
vpH		7.10 ± .07	7.07 ± .03	7.15 ± .08	7.11 ± .03	7.2 ± .11	7.10 ± .05	7.18 ± .15	7.14 ± .05
P_{aO_2}		170 ± 11**	106 ± 16	180 ± 3.6**	108 ± 25	177 ± 1.5*	114 ± 29	188 ± 2	114 ± 36
P_{vO_2}		26 ± 5.3	24 ± 1.5	25 ± 3.2	22 ± 2.8	23 ± 2.8	25 ± 2.5	22 ± 1.4	24 ± .57
P_{aCO_2}		21 ± 2.3**	44 ± 6.1	16 ± 2.6**	42 ± 3	14 ± 2**	45 ± 3	13 ± 2**	46 ± 2.5
P_{vCO_2}		49 ± 4.6*	73 ± 8.5	39 ± 2.8**	70 ± 3.2	33 ± .70**	72 ± 2	31 ± .70**	69 ± 2.6
P_{cCO_2}		47 ± 5.7	60 ± 6.6	37 ± 6*	58 ± 6.6	31 ± 4.2*	58 ± 9.2	29 ± 4.2**	61 ± 5.8
SeO_2		99 ± .57*	96 ± 1.5	99 ± .57	96 ± 2	99 ± .05	97 ± 2	99 ± .05	96 ± 2.5
SwO_2		31 ± 14.7	25 ± 3.6	32 ± 11.2	24 ± 5.5	29 ± 12	27 ± 5.7	27 ± 4.9	29 ± 2
ScO_2		41 ± 14.5	31 ± 6.4	44 ± .17	31 ± 3	44 ± .70	45 ± 21	37 ± 2.1	42 ± 11
aLact		8.1 ± 1.4	9.4 ± 2.6	9.3 ± 2.4	10.5 ± 3.2	10.1 ± 2.5	11.3 ± 4	10.9 ± 3	11.1 ± 4.2
cLact		7.4 ± .83	8.1 ± 2.2	8.2 ± 1.8	9.3 ± 3.1	9 ± 3.7	10.5 ± 3.6	8.4 ± 1.5	11.5 ± 5.5

x ± SD; * = p<.05; ** = p<.01; a = Arterial; v = Mixed Venous; c = Cerebral; PO_2 = mmHg; PCO_2 = mmHg; Lact = mmol/L

AN INTUBATION SUCTION STYLET

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S. Hamid, M.D., St. Elizabeth Hospital, Utica, NY 13501 USA

At times, laryngoscopic intubation, especially in emergency and pre-hospital work, is quite difficult due to vomitus, excess secretions, bleeding, anatomy, etc. The repeated suctioning often necessary, at times, involves picking up the suction cannula, suctioning; then exchanging it for the ETT. This may have to be repeated one or more times, exchanging the suction cannula for the ETT, and uses up valuable time.

We have developed a springy, atraumatic, 6 mm. O.D., hollow, curved plastic stylet that can be used with the laryngoscope for suctioning, and then immediately inserted through the glottis as soon as it is visualized. The laryngoscope is removed and the ETT, which has already been threaded on the outer flexible segment of the stylet, is slid over it into the trachea and the stylet is withdrawn.

The hollow stylet has a small opening which is covered by the index finger when suction is desired. With the insertion of the stylet, suction is eliminated as the finger is removed.

The use of a solid stylet inserted through the glottis to guide the ETT in intubation is not new. In fact, MacIntosh (1) in 1949 described the use of a solid flexible stylet as an aid in guiding the ETT through the glottis into the trachea. We present our experience in the use of a hollow suction stylet in anesthesia, pre-hospital applications and in emergencies.

1. MacIntosh RR. An Aid to Oral Intubation. Br. Med J. 1949; 1:28.

PREDICTION OF MORTALITY IN ELDERLY PATIENTS USING ASA CLASSIFICATION FOLLOWING BLUNT TRAUMA.

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The American Society of Anesthesiologists (ASA) physical status classification is a subjective assessment made by the anesthesiologist as part of the preoperative assessment. Although not intended for use as a predictor of outcome, studies have shown ASA status to correlate with postoperative morbidity and mortality¹. Current scoring systems such as Glasgow coma score(GCS), Injury Severity Score(ISS) and Trauma Score(TS) have been shown to identify patients with lethal injuries. None of these scoring systems take the preinjury medical condition of the patient into account, a factor which should influence outcome in older patients. Only one study has tried to correlate ASA with outcome² in the trauma population, but not specifically in old age.

We reviewed all patients over the age of 70 years admitted to the R Adams Cowley Shock Trauma Centre to determine whether or not ASA status correlated with mortality in this group of patients.

2643 patients were admitted to MIEMSS between July 1990 and June 1991. 127 patients were over the age of 70 years. 32 of these patients died before leaving hospital (25.1%). Patients were assessed and given an ASA score by a member of anesthesia staff within 30 minutes of admission to the admitting area. Assigned ASA status is shown in table 1. ISS was assessed retrospectively.

All patients assigned ASA 5 died. There was a significant correlation between ASA and mortality ($p<0.0001$, Wilcoxon signed rank). There was also a significant correlation between between ISS and mortality($p<0.0001$,spearman rank) but not between age and mortality($p<.12$).

ASA Class	IE	IIE	IIIE	IVE	VE
Number	0	30	66	20	11
% Total		(23.6)	(52)	(15.7)	(8.7)
Survivors	0	27	60	7	0
% of Class		(93)	(91)	(35)	(0)
Died	0	2	6	13	11
% of Class		(7)	(9)	(65)	(100)

Table 1: Physical Status as related to death

Total(N)	127
Deaths	32
Age	78(70-97)
ISS	14.9(0-66)
GCS	12.9(3-15)

Table 2: Demographic data

Although ASA is a subjective assessment of injury it seems to be a good predictor of mortality in patients older than 70 years($p=0.0001$). The ASA status assessment is made at an early stage(<30 mins) so it seems that a trauma anesthesiologist can predict outcome from this time. Other scoring systems such as ISS, GCS and TS(Trauma score) deal only with admission injury and do not reflect other concurrent illness, which is extremely relevant in the older population. Age itself correlated poorly with outcome in the trauma population.

1. Koch J. Is the ASA physical status classification adequate in predicting mortality in blunt trauma. Abstract. Anesthesiology V67, Sept 87
2. Forrest JB et al. Multicenter study of general anesthesia, Predictors of severe perioperative adverse outcomes. Anesthesiology 76:3-15, 1992.

**ROLE OF ANAESTHESIOLOGIST IN MANAGEMENT OF MASS CASUALTIES
FOLLOWING VIOLENCE : A RECENT EXPERIENCE.**

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INDIA

Trauma and mass casualties have become a part of life in this subcontinent. Each episode makes us aware of the state of unpreparedness in handling these situations. In recent past, we had several tragic incidents leading to mass casualties. We present a review of one such occurrence of arson, mob violence and group clashes involving eastern part of the city of Delhi. It resulted in a large number of casualties (Over 100) arriving at our hospital within a short span of time. All this was within a radius of 5 Kms. of this hospital. The types of injury ranged from simple blunt injuries requiring first aid to severe gun shot and sharp penetrating injuries requiring perioperative critical care. The role of an anaesthesiologist in management of these victims is discussed.

THE INSPIRATORY WORK OF BREATHING ACROSS TRANSTRACHEAL CANNULAE

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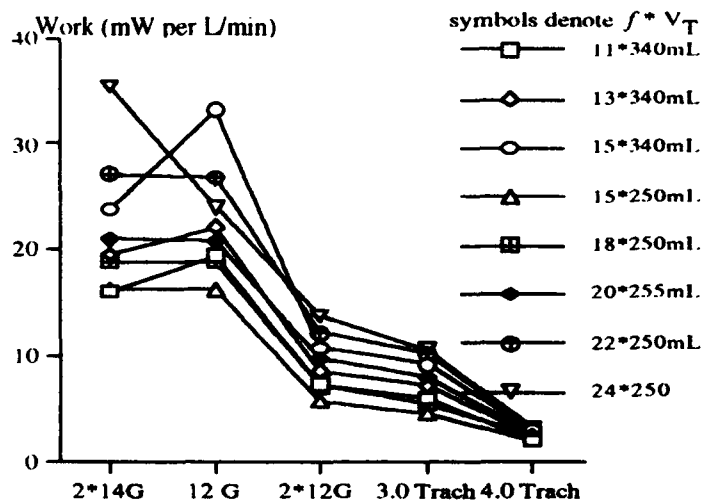
The use of a large bore intravascular(IV) catheter for percutaneous transtracheal cannulation has been shown to impose an excessive workload on spontaneous ventilation¹. However, there is evidence to suggest that the use of two large-bore IV cannulae together, may be compatible with spontaneous ventilation². The present study therefore examined the inspiratory workload imposed by a variety of cannulae, including the use of two IV cannulae together.

The inspiratory workload associated with the use of two 14-G(2*14-G), two 12-G(2*12-G), single 12-G intravascular cannulae as well as 4.0 and 3.0 mm-ID pediatric tracheostomy tubes were examined. Spontaneous ventilation was simulated using a lung model(sine-wave respiratory flow). Work was represented by the inspiratory power of ventilation(\dot{W}_{spont}) across the cannula and obtained from the equation: $\dot{W}_{spont} = \left[\int p \dot{v} dt \right] f / 60 MV$ where p and \dot{v} are the instantaneous airway pressure(pressure transducer) and respiratory flow (pneumotachograph) respectively; and f and MV(integral of flow) are the respiratory frequency (breaths per minute, bpm) and minute ventilation. The experiment was divided into two parts: A) tidal volume (V_T) of 340 mL and f of 11, 13 and 15 bpm; B) V_T of 250mL and f of 15, 18, 20, 22 and 24 bpm.

\dot{W}_{spont} ranged between 2.0 and 35.4 mWL⁻¹min; the smallest values were obtained with the 4.0-mm ID tube (see fig). The 2*14-G and the 12-G intravascular cannulae gave the largest values.

Since the normal work of ventilation ranges between 9-14 mW, and that few patients can sustain spontaneous ventilation when \dot{W}_{spont} is 300-400% normal(18-42 mWL⁻¹min)³, the use of 2*14-G cannulae or a single 12-G cannula will impose an excessive workload. Better alternatives would be the 2*12-G, 3.0 and 4.0 tubes (2-13.9 mWL⁻¹min), the latter being compatible with easy insertion by the percutaneous transtracheal route.

References: 1 New England Journal of Medicine 262: 511-3 1960. 2. Anesthesiology 75: 531-3,1991 3. Brit J Anaesth 70: 17-21, 1993



PEROPERATIVE AUTOTRANSFUSION FOR SPINAL TRAUMA IN EMERGENCY

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Transfusion safety and saving blood are currently essential. Peroperative autotransfusion has become a common practice in traumatology (3). The study aims to assess the use of an autotransfuser (cell saver IV, Haemonetics) in emergencies and define the role of autotransfusion within the framework of traumatic spinal surgery.

A retrospective study was made in the emergency department of our University Hospital over a 33-month period. Seventy-nine files were studied. Operative indications were broken down into 5 groups: dorso-lumbar spinal trauma (group I, n=24), hemoperitoneum (group II, n=43), hemostatic thoracotomy (group III, n=2), vascular lesion (group IV, n=8), non spinal osseous lesion (group V, n=2). For the 24 patients operated for dorso-lumbar trauma, the following parameters were studied: age, sex, type, duration and period of the operation, existence of associated bleeding, preoperative, immediate- and delayed-postoperative and biological tests, peroperative vascular filling and autotransfusion.

Patient characteristics and autotransfused volumes for all the patients and for group I are shown in Chart I. Out of the 24 patients with a dorso-lumbar lesion, 19 were operated in the first 24 hours. The operation lasted an average of 246 ± 63 min. In a third of the cases, there was associated bleeding. Chart II sums up the perioperative biological results. In the preoperative phase, half of the patients required vascular filling by macro-molecules or human plasmatic albumine (average of 900 ml). Only patients with associated bleeding lesions received blood derivatives; the same is true during the operation. In the peroperative phase, autotransfusion (Chart I) proved sufficient for 3 patients. Associated vascular filling was 830 ml on average. In the postoperative phase, a third of the patients were transfused. For the others, filling never exceeded 500 ml.

Peroperative autotransfusion was initially intended for vascular surgery (1). Nevertheless, dorso-lumbar spinal surgery can widely benefit from it. This hemorrhagic operation can often be performed without transfusion thanks to this technique, as the level of postoperative haemoglobin shows (Chart II). No repercussions were noted on haemostasis but the quantity of retransfused blood was never very substantial. Lastly, this technique can be completed advantageously by postoperative autotransfusion (2).

Chart I : Patient characteristics and autotransfused volumes (ml)

	sex (M/F)	age	vol.processed	vol. retransfused	%
(0)	63/16	37 ± 18	2521 ± 2246	821 ± 808	32 ± 21
(I)	19/5	35 ± 14	1809 ± 1166	528 ± 358	29 ± 19

(0) : overall population

(I) : spinal trauma

Chart II : Biological Results

	Hb	Ht	Plat	PL	Fibri.
Pre.	$13 \pm 2,1$	$39,5 \pm 5,5$	249 ± 64	90 ± 12	$2,6 \pm 1,0$
P.1	$9,9 \pm 2,0$	$29,7 \pm 6,0$	169 ± 63	67 ± 16	$2,0 \pm 1,1$
P.2	$10,4 \pm 1,1$	$30,9 \pm 3,3$	173 ± 63	76 ± 14	$2,5 \pm 0,6$

Pre : preoperative. P.1 : immediate postop. P2 : delayed postop

Hb : haemoglobin g/100 ml. Ht : haematocrit %

Plat : platelets G/l. PL : prothrombin level %

Fibri : fibrinogen

References :

1. Gillot A et al. *Am Surg*, 50 : 609-612, 1984
2. Guerrero M et coll. *Ann Fr Anesth Reanim*, 12 : 11-16, 1993
3. Jurkovich GJ et al. *Am J Surg*, 148 : 782-786, 1984

PREVENTION OF THROMBOEMBOLISM AFTER SPINAL CORD INJURY USING LOW -MOLECULAR -WEIGHT HEPARIN

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Deep venous thrombosis (DVT) and pulmonary embolism (PE) are serious and frequent complications occurring in the spinal cord injured patients with paralysis. Various methods of prophylaxis have been used to decrease its frequency but none of these methods has been completely effective and some carry a definite risk of bleeding (1). The aim of this paper was to evaluate the efficiency and the safety of a low molecular weight heparin (LMWH) in patients with complete motor paralysis after spinal cord injury.

During a one-year period (1992), 60 consecutive patients with an isolated spinal cord injury and complete motor paralysis, were included in this prospective study. They were 31 paraplegic and 29 quadriplegic patients. None of them presented any other traumatic lesions nor contraindications to anticoagulation. Color duplex doppler imaging was performed on all patients within the first 24 hours after injury in order to eliminate any DVT. The treatment was surgical in 55 patients and orthopedic in 5. In all cases of surgical procedures the operation was done within the first 24 hours after the initial injury. Prophylaxis was accomplished with a LMWH (Enoxaparin) 40 mg daily given subcutaneously 24 hours after surgery in 55 patients and 24 hours after injury in the 5 nonoperated patients. All patients were examined daily for symptoms and clinical signs of DVT, PE, and bleeding. Activated partial thromboplastin time tests, blood cells and platelets counts were done the first and third day then weekly. Color duplex doppler imaging was done weekly during 8 weeks. The occurrence of DVT was confirmed in positive case by veinography. The occurrence of PE was confirmed by pulmonary angiography.

Three patients (5%) presented DVT, one (1.6%) presented PE. Two quadriplegic patients had calf vein thrombi which were detected at the third week although none of them presented evident clinical signs of DVT. One paraplegic who presented some dyspnea between the third and the fourth week had a femoral thrombus and PE demonstrated by pulmonary angiography. There were neither fatal complications nor episodes of significant bleeding; the platelets counts remained stable.

In patients with spinal cord injury and complete motor paralysis, DVT occurs in 70% cases in the absence of prophylaxis (2), in 30% cases when using standard heparin (3). In such indications, the LMWH has proven his superiority to standard heparin in fixed doses (4). Green et al. (5) using logiparin, noted an 8.3% DVT rate and a 1.6% PE rate; he confirmed its safety and effectiveness. In the present study, the very low incidence of DVT (5%) and non fatal PE (1.6%) plus the absence of hemorrhagic complications demonstrated the efficiency and safety of Enoxaparin to prevent the thromboembolism in these high risk patients.

1- Hull R.D. Venous thromboembolism in spinal cord injury patients, *Chest* 1992, 102: S658-S663

2- Brach B. et al. Venous thrombosis in acute spinal cord paralysis, *J. Trauma* 1977, 17: 289-292

3- Green D. et al. Fixed VS adjusted-dose heparin in the prophylaxis of thromboembolism in spinal cord injury, *JAMA* 1988, 260: 1255-1258

4-Green D et al. Prevention of thromboembolism after spinal cord injury using low-molecular-weight heparin, *Ann Intern Med* 1990, 113:571-574.

5-Green D. Prophylaxis of thromboembolism in spinal cord-injured patients, *Chest* 1992, 102: S649-S651.

SIMULTANEOUS SESSION IV.

Special CRNA Session: Part II

This special session for CRNAs (as well as interested physician anesthesiologists) has been developed by CRNAs who are actively involved in the MIEMSS and other outstanding trauma centers to address major issues in providing critical care anesthesia skills for seriously injured trauma patients. The topics addressed will give practical information on resuscitation, stabilization, and appropriate anesthesia care delivery to complement the main symposium program material. While the main symposium program will provide a comprehensive conceptual framework, this session emphasizes the practical skills needed in the care of trauma patients.

Moderator-in-Chief: Charles R. Barton, CRNA MEd

*New Concepts in Pain Management of
Trauma Patients*

Russell Baker, CRNA, MS

Neurological Evaluation of the Trauma Patient

Robert Akins, CRNA, BS

Fluid Resuscitation of the Trauma Patient – Part I

Mark Kossick, CRNA, MS

Fluid Resuscitation of the Trauma Patient – Part II

Mark Kossick, CRNA, MS

*Anesthetic Management of the Patient Sustaining
Abdominal Trauma*

Patricia Taub, CRNA, BS

*Anesthetic Management of the Pregnant
Trauma Patient*

Charles R. Barton, CRNA, MEd

*Anesthetic Management of Severe Maxillofacial
Injuries*

Robert Akins, CRNA, BS

CONCEPTS IN PAIN MANAGEMENT OF TRAUMA PATIENTS

C. Russel Baker, CRNA

I. Basic Aspects of Pain

A. Physiologic Factors Effecting Pain

1. Peripheral mechanisms of Nociception

- a. Cutaneous CMH and AMH Receptors**
- b. Free Afferent Nerve Endings Cardiovascular**
- c. Hyperalgesia and caused by Sensitization of Nociceptors**
- d. Prostaglandins Role in Inflammatory Pain**

2. Central Mechanisms of Nociception

a. Endogenous Pain Control Mechanisms

- 1. Opioid-mediated Analgesia Induction.**
- 2. Receptors are Located in Several Areas of the Brain and Spinal Cord.**

b. Role of the Dorsal Horn (Gate Theory)

- 1. Response to Peripheral Input**
- 2. Response to Descending Input**

B. Psycho/Social Factors Affecting Pain

1. Emotional State

- a. Depression and Degree of Neuroticism Variable**
- b. Anxiety Most Reliably Related to Pain**

2. Psychological Factors

- a. Patient's Mental State at the Time of the**

Accident.

- b. Sense of Responsibility for the Accident**
- c. Reaction to the Effects on Others**
- d. The Degree of Memory for the Event**
- e. Coping Skills the Patient Uses Under Stress**

3. Social Factors

- a. Availability of Social Support**
- b. Financial Responsibility**
- c. Legal Complications**
- d. Loss of Significant Other in Accident**

C. Treatment of Acute Pain

1. Pharmacologic

- a. Narcotics**
- b. NSAIDs**
- c. Local Agents**

2. Cognitive Strategies

- a. Distraction**
- b. Hypnosis**
- c. Pre-operative Education**

II. Are Trauma Patients Different From Other Patients With Acute Pain?

A. MIEMSS Acute Pain Service Data

B. Comparison of Pain Scores

III. Potential Differences Between Trauma and Non-Trauma Patients.

A. Demographics of Trauma

B. Theoretical Concerns

1. Sudden Onset
2. Possible Legal Implications
3. Death of Significant Other
4. Health Care Provider Not of Patient's Choosing
5. Long Term Implications: Inability to Return to Job
6. Release of Multiple Mediators Secondary to Trauma
 - a. Bradykinin
 - b. Eicosanoids
 - c. Histamine

C. Practical Concerns

1. Multiple Soft Tissue Injuries Requiring Multiple Dressing Changes
2. Compartment Syndrome
3. Deafferentation and Central Pain
 - a. Phantom and Stump Pain
 - b. Central Pain of Cord Origin
4. Substance Abuser
 - a. Four Categories of Substance Abuser
 1. Physical Dependence Without Psychologic Dependence
 2. Iatrogenic Dependence with Physiologic Reinforcers
 3. Physical and Psychologic Dependence
 4. Potential for Psychologic Dependence but

no Physical Dependence

b. Management Plan

- 1. Be Prepared for Post-Operative Difficulties**
- 2. Patient will Require Large Doses of Narcotics**
- 3. Patient Contract with Well Defined Plan**

c. Immediate Post-Operative Period

- 1. Goal to Control Pain but Avoid Overdose (OD)**
- 2. If OD Occurs, Toxicology Screen Should be Performed to Rule-Out Illicit Drugs.**

d. Long Term Plans

- 1. Patient with Rapidly Declining Pain Needs to be Weened Rapidly**
- 2. Patients with Chronic Pain Syndromes Need to be Weened Gradually with Multi-Disciplinary Approach**
- 3. Opioid Maintenance Program may need to be Considered**

IV. Summary - Three Distinct Populations

- A. Traditional Acute Pain**
- B. Sub-Acute Pain with Chronic Pain Component**
- C. Chronic Pain**

V. Summary and Conclusions

NEUROLOGICAL EVALUATION THE TRAUMA PATIENT

Robert Akins, CNRA, BS

I. History

- A. Events Preceding the Incident**
- B. Factors Affecting the Neuro Status**

II. Observation of the Results of Resuscitation

- A. Mental Status**
- B. Respiratory Pattern**
- C. Movement of Extremities**

III. Physical Exam

- A. Head and Neck**
- B. Mental Status**
- C. Cranial Nerves, Motor and Sensory Responses, Reflexes**

IV. Peripheral Stimulation

- A. Sensory and Motor Fibers**
- B. Strength of the Reaction Grading**

V. Tone and Reflexes

- A. Confirms Neurological Deficits**

VI. Followup

- A. Repeat Every 5 to 10 Minutes**
- B. Prevent Permanent Neural Damage**

FLUID RESUSCITATION OF THE TRAUMA PATIENT

Mark A. Kossick, CRNA, MS

I. Considerations Related to Fluid Resuscitation

II. Classification of Shock

- A. Cardiogenic**
- B. Distributive**
- C. Obstructive**
- D. Hypovolemic**

III. Assessment of Volume Status

- A. Peripheral Hemodynamics and Perfusion**
- B. Urinary Output**
- C. Level of Consciousness**
- D. Central Venous/Pulmonary Pressures**

IV. Techniques/Apparatus for Volume Replacement

V. Selection and Types of Fluids for Volume Replacement

- A. Hypertonic Saline**
- B. Colloids Versus Crystalloids**
- C. Blood Products**

VI. Complications with Fluid Resuscitation

- A. Crystalloids**

B. Colloids

C. Blood Products

- 1. Hypothermia**
- 2. Citrate Intoxication**
- 3. Hyperkalemia**
- 4. Oxygen Transport and Delivery**
- 5. Infectious Disease Transmission**

ANESTHESIA MANAGEMENT OF THE PATIENT WITH ABDOMINAL TRAUMA

Patricia Taub, CRNA, BS

- I. Introduction and Demographics**
- II. Blunt Versus Penetrating Trauma of the Abdomen**
- III. Initial Evaluation and Fluid Resuscitation**
- IV. Diagnostic Procedures**
 - A. Diagnostic Peritoneal Lavage**
 - B. CAT Scan, MRI**
 - C. Airway, Ventilation, Anesthesia Support**
- V. Specific Injuries**
 - A. Liver**
 - B. Spleen**
 - C. Major Vessels, Aorta, Vena Cava, Hepatic/Portal Vein**
 - D. Kidney, Bladder, Ovaries**
 - E. Retroperitoneal**
 - F. Diaphragm, Stomach, Pancreatic, Intestinal**
- VI. Anesthetic Consideration**
 - A. Securing the Airway**
 - B. Fluids and Blood**
 - C. Anesthetic Agents and Techniques**

ANESTHETIC MANAGEMENT OF THE PREGNANT TRAUMA PATIENT

Charles R. Barton, CRNA, M.Ed.

I. Introduction

- A. Demographic of Pregnancy and Trauma**
- B. Principles of Management for Pregnant Patients Sustaining Trauma**

II. Physiological Changes of Pregnancy

- A. Respiratory System**
- B. Cardiovascular System**
- C. Gastrointestinal System**
- D. Genitourinary System**

III. Blunt and Penetrating Injuries

- A. Mechanisms of Injury**
- B. Motor Vehicular Trauma**

IV. Diagnostic Tests, Procedures, and Monitoring

- A. Laboratory Studies**
- B. Sonography, Radiographic Studies**
- C. Paracentesis and Peritoneal Lavage**
- D. Amniocentesis, Fetal and Maternal Monitoring**

V. Monitoring and Other Considerations

- A. Need for A-Line, CVP, PA Catheter**

- B. Positioning
- C. Pulmonary Considerations, Respiratory Function Measurements
- D. Steroids, Peptic Ulcer Prophylaxis
- D. Deep Venous Thrombosis Prophylaxis

VI. Surgical Interventions and Anesthesia Approach

- A. Immobilization Devices, Halo Vests
- B. Early Surgical Decompression, Stabilization
- C. Anesthetic Approach
- D. Anesthetic Drugs and Techniques

ANESTHETIC MANAGEMENT OF SEVERE MAXILLOFACIAL INJURIES

Robert Akins, CRNA

- I. Introduction and Anatomy**
- II. Mechanisms of Maxillofacial Injuries**
- III. Commonly Injured Facial Structures**
 - A. LeFort I, II, and III**
 - B. Mandibular Injuries**
 - C. Maxillary Injuries**
 - D. Skull and Cranial Vault Injuries**
- IV. Preoperative Evaluation**
- V. Airway Assessment and Interventions**
 - A. Oral Versus Nasal Intubations**
 - B. Awake Versus General Anesthesia Intubation**
- VI. Anesthetic Management**
 - A. Agents and Techniques**

PLENARY SESSION 8:

Forum on Prehospital Trauma Anesthesia

Moderator: Wolfgang F. Dick, MD, PhD, FFARCS (Hon)

Efficacy of Prehospital Measures in Trauma Patients

Wolfgang F. Dick, MD, PhD, FFARCS (Hon)

Role of the Trauma Anesthesiologist: Diagnostics From the Field Through to the ICU

Margaret Hemmer, MD

Controversies with Medical Antishock Trousers in Trauma

Bruno Riou, MD

Anesthesiologists in the Field: The Berlin Experience

Armin Rieger, MD

Anesthesia and Critical Care in the Field and During Transport

Pierre A Carli, MD

Dicussion

EFFICACY OF PREHOSPITAL MEASURES IN TRAUMA

Wolfgang F. Dick, M.D.

I. Introduction: Structure and Organization of Emergency Medical Services Systems

- A. First Responders**
- B. Second Responders**
- C. System Activation**
- D. Qualifications**
- E. Response Intervals**
- F. Critical Intervals**

II. Efficacy Criteria

- A. Prehospital Scores**
- B. Scores to Validate Patient's Condition**
- C. Outcome Scores**

III. Efficacy of Prehospital Measures

- A. I.V. Lines and Fluids**
- B. Hypertonic, Hyperosmotic Fluids**
- C. Time to Place I.V. Lines**
- D. Pain Treatment**
- E. Endotracheal Intubation**
- F. Ventilation and Gas Exchange (Importance of PCO₂)**

IV. Presence of Emergency Physicians at the Scene

V. Efficacy of Non-Physician Personnel at the Scene

VI. Prehospital Time Versus Outcome

VII. Outcome/Effectiveness

VIII. Conclusions

**ROLE OF THE TRAUMA ANESTHESIOLOGIST: DIAGNOSTICS FROM THE FIELD
THROUGH TO THE ICU**

Margaret Hemmer, M.D.

- I. Introduction: Specific approach to trauma management in
Centre Hospitalier, Luxembourg**
 - A. One Team for Both Prehospital and In-Hospital Trauma Care**
 - B. Leading Role of Anesthesiologist in the Multidisciplinary
Management of Trauma.**
 - C. Interventional Radiologist - A New and Essential Partner
in the Trauma Team**

- II. In Field Triage: Priorities for Further Diagnostic Procedures**

- III. Choice of Diagnostic Modalities: When and Why**
 - A. Conventional Radiology**
 - B. Ultrasonography**
 - C. The Essential Role of CT in Management of Blunt Trauma**
 - D. Emergency Angiography**

- IV. Choice of Therapeutic Modalities**
 - A. Conservative Treatment**
 - B. Interventional Radiology**
 - C. Emergency Surgery**
 - D. Delayed Surgery**

V. Influence of the Initial Diagnosis and Treatment on the
Outcome From Blunt Trauma

VI. Conclusion

CONTROVERSITIES WITH MEDICAL ANTISHOCK TROUSERS IN TRAUMA

Bruno Riou, M.D.

I. Introduction

- A. History of the MAST**
- B. Description**

II. The Effects of MAST

- A. Cardiovascular Effects**
 - 1. Preload**
 - 2. Afterload**
 - 3. Regional Circulations**
- B. Hemostatic Effects**
- C. Ventilatory Effects**
- D. Transmission of the Pressure**

III. Does MAST Improve the Prognosis

- A. Experimental Studies**
- B. Clinical Studies**
- C. Analysis of the Controversies**

IV. Clinical Use of MAST

- A. Hemorrhage Shock**
 - 1. Inflation**
 - 2. Deflation**
 - 3. Evaluation of the Severity of Shock in a Trauma**

Patient with MAST

B. Pelvic Trauma

C. MAST and CPR

1. Normovolemia

2. Hypovolemia

V. Conclusion

A. Proposition of Guidelines

B. What Studies Should be Done?

ANESTHESIOLOGISTS IN THE FIELD: THE BERLIN EXPERIENCE

Armin Rieger, M.D.

- I. A Brief Historical Review on the Development and Organization of the Emergency Services Systems in:**
 - A. Germany**
 - B. West-Berlin**

- II. The Goal of Prehospital Emergency Care in Trauma Patients**
 - A. Stabilization in the Field**
 - B. Transport**
 - C. Assignment to Designated Trauma Centers**

- III. Study on the Prehospital Management of Trauma Patients at the University Medical Center in Steglitz, Berlin**
 - A. Incidence of Severe Trauma**
 - B. The Severity of the Injury**
 - C. Patterns of Injury**
 - D. Indications for Prehospital Treatment by an Emergency Physician (Anesthesiologist, etc.)**
 - E. Measures Performed by the Emergency Physician (Anesthesiologist, etc.) at the Scene of the Accident**
 - i. Venous Access**
 - ii. Airway Management and Monitoring**
 - iii. Surgical Interventions**
 - iv. Drug Therapy**

v. Volume Replacement

IV. Outcome

V. Conclusion

**ANESTHESIA, ANALGESIA AND CRITICAL CARE IN THE FIELD AND DURING
TRANSPORT**

Pierre A. Carli, M.D.

- I. Adverse Effect of Acute Pain of Analgesia/Anesthesia**
 - A. Acute Pain Related to Trauma**
 - B. Adverse Effects of Pain**
 - C. Adverse Effects of Analgesia**

- II. Prehospital Pain Management**
 - A. Physical Assessment on Scene**
 - B. Stabilization of Life Threatening Problems**
 - C. The Choice of the Anesthesia/Analgesia Technique**
 - D. Influence of Prehospital Care Systems**

- III. Techniques of Prehospital Analgesia**
 - A. Non-Specific Procedures**
 - B. Nitrous Oxide**
 - C. Minor Drugs**
 - D. Opiate Agonists**
 - E. Opiate Agonist-Antagonists**

- IV. Techniques of Prehospital Regional Analgesia**
 - A. Nerve Blocks: General Indications**
 - B. Adverse Effects of Nerve Blocks**
 - C. Major Nerve Block Techniques**

- D. Femoral Block, Technical Efficiency
- E. Sciatic Block
- F. Axillary Block

V. Prehospital Intravenous Anesthesia

- A. Indications
- B. Advantages
- C. Adverse Effects
- D. Ketamine
- E. Etomidate
- F. Other Hypnotics
- G. Muscle Relaxant

VI. In-Hospital Management of the Patient Anesthetized on Scene

VII. Conclusion

PLENARY SESSION 9:
Forum on Neurotrauma

Moderator: Elizabeth A. M. Frost, MD

Perioperative Anesthetic Management of Maxillofacial Trauma
Alexander W. Gotta, MD

Physiologic Considerations in the Management of Acute Head Injury
Donald S. Prough, MD

Non-Neurosurgical Complications of Severe Head Trauma
Margaret Hemmer, MD

Perioperative Anesthetic Management of Severe Head Trauma
Elizabeth A. M. Frost, MD

Measurement of Brain Tissue Oxygenation with Near Infrared Spectroscopy
Kazuo Okada, MD

Discussion

MAXILLOFACIAL TRAUMA

Alexander W. Gotta, M.D.

I. Normal Anatomy

- A. Division of Facial Skeleton into Thirds**
- B. Maxilla**
- C. Mandible**

II. Mechanisms of Force Dispersion

- A. Vulnerability of Mandible**
- B. Vulnerability of Maxilla**
- C. Nature of Blow determines Fracture Site and Extent**

III. Common Facial Fractures

- A. LeFort I**
- B. LeFort II**
- C. LeFort III**
- D. Mandibular Fractures**
- E. Maxillary Fractures**
- F. Possible Involvement of Base of Skull and Cranial Vault**

IV. Preoperative Evaluation

- A. Common Concurrent Medical Problems**
 - 1. Myocardial Infarct**
 - 2. Stroke**
 - 3. Drug Abuse**

1. Brain Coverings

- a. Depressed Skull Fractures under lacerations should be Elevated and Debrided Within 24 Hours to Minimize Infection
- b. Bony Fractures or any other Foreign Bodies should not be Manipulated in the Emergency Room as they may be traversing a Major Vessel or Dural Sinus.
- c. Movement or Removal of a Weapon such as a knife under less than totally controlled circumstances may cause Catastrophic Bleeding or Aspiration of Air

2. Gunshot Wounds

- a. In the United States, more than 15,000 people die annually from Gunshot Wounds to the Head.
- b. Civilian Missile Injuries are usually due to relatively Low Velocity Bullets
- c. Three Distinct Types of Pressure are generated by a Missile moving through a Tissue Medium:
 - i. Juxta-Missile Pressure
 - ii. Longitudinal "Strong" Shock Waves
 - iii. Pressure Waves from Kinetic Energy Transfer
- d. Epidural, Subdural or Intracerebral Hematomas Result in Up to 50% of Cases
- e. Devitalized Brain Tissue may act as a Mass

C. Superior Laryngeal Nerve Block

- 1. Anatomy**
- 2. Technique**
- 3. Indications**
- 4. Contraindications**

VII. Tracheostomy

- A. Indications**
- B. Contraindications**

VIII. Choice of Anesthetic Agent and Technique

- A. Intravenous Agents**
 - 1. Narcotics**
 - 2. Ketamine**
- B. Inhalation Agents**
 - 1. Alkanes**
 - a. Cardiac Arrhythmias**
 - 2. Ethers**
- C. Local Anesthetics**

IX. Conclusions

NON NEUROSURGICAL COMPLICATIONS OF SEVERE HEAD TRAUMA

Margaret Hemmer, M.D.

- I. Systemic Response to Severe Brain Injury**
 - A. Acute Phase Response to Severe Head Trauma**
 - B. Management of Cardiovascular Abnormalities**
 - C. Management of Early and Late Pulmonary Dysfunction**
 - D. Fluid and Electrolyte Disorders**
 - E. Nutritional Support**
 - F. Early and Late Coagulation Disorders**
 - G. Diagnosis and Treatment of Associated Injuries**

- II. Infectious Complications in Neurotrauma Patients: Incidence, Risk Factors, Treatment**
 - A. Sinusitis**
 - B. Posttraumatic Meningitis**
 - C. Nosocomial Pneumonia**
 - D. Device-Related Infections**
 - E. Principles of Antibiotic Treatment**

ANESTHESIA FOR HEAD TRAUMA

Elizabeth A.M. Frost, M.D.

I. Introduction

A. Anesthesiologists are Involved in Several Critical Steps in the Care of the Head Injured Patient:

- 1. Initial Resuscitation**
- 2. Intraoperative Management**
- 3. Postoperative Care**

II. Demographics

A. Most Head Injuries occur and Present to the Emergency Room:

- 1. Between 4 PM and Midnight**
- 2. On Fridays and Saturdays**
- 3. Males outnumber Females by Three to One over an Age Range of 2-65 Years**
- 4. Alcohol Use is Related to Brain Injury as a Causation Factor and as a Factor Complicating Diagnosis, Recovery and Survival After Injury.**
 - a. Significant Blood Alcohol Levels found in More Than 50% of Head Injured Patients**

III. Management

A. Therapy of Head Injury must be Adjusted to the Type and Location of Insult as Follows:

1. Brain Coverings

- a. Depressed Skull Fractures under lacerations should be Elevated and Debrided Within 24 Hours to Minimize Infection
- b. Bony Fractures or any other Foreign Bodies should not be Manipulated in the Emergency Room as they may be traversing a Major Vessel or Dural Sinus.
- c. Movement or Removal of a Weapon such as a knife under less than totally controlled circumstances may cause Catastrophic Bleeding or Aspiration of Air

2. Gunshot Wounds

- a. In the United States, more than 15,000 people die annually from Gunshot Wounds to the Head.
- b. Civilian Missile Injuries are usually due to relatively Low Velocity Bullets
- c. Three Distinct Types of Pressure are generated by a Missile moving through a Tissue Medium:
 - i. Juxta-Missile Pressure
 - ii. Longitudinal "Strong" Shock Waves
 - iii. Pressure Waves from Kinetic Energy Transfer
- d. Epidural, Subdural or Intracerebral Hematomas Result in Up to 50% of Cases
- e. Devitalized Brain Tissue may act as a Mass

Lesion causing extremely high levels of Intracranial Pressure (ICP)

- f. Chemical Control of Cerebral Blood Flow (CBF) is impaired and brain vasculature loses CO₂ Responsivity
- g. Paradoxically, brain around the wound track shows decreased flow in response to Hypercarbia that may represent a "Steal" Phenomenon.
- h. Surgery is aimed at Debridement and Clot Evacuation but the Prognosis is generally very Poor
- i. The Major Contaminant is Staphylococcus and appropriate Antibiotic Therapy is indicated
- j. If Vancomycin is used, infusion must be over at least one hour to minimize the Risk of Hypotension due to Histamine Release and Cardiac Depression.

3. Epidural Hematoma

- a. Traumatic Epidural Hematoma, usually the result of an Automobile Accident, is rare
- b. Common injuries involve lacerations of Middle Meningeal Vessels or Dural Sinuses
- c. Patients are usually under 20 years of age
- d. Clinical course with Arterial Bleeding is one of Rapid Deterioration following a Lucid

Interval

- e. Clinical signs of Tentorial Herniation with Ipsilateral Third Cranial Nerve Palsy are often present
- f. Treatment should not be delayed pending Radiologic Evaluation or Cannulation of Central Vessels. This situation represents an Extreme Emergency
- g. Venous Epidural Hematoma develops more Slowly and time for diagnostic testing may be available

4. Subdural Hematoma (SDH)

- a. Most common cause of Subdural Hematoma (SDH) is Trauma (75%)
- b. May also occur spontaneously associated with various Coagulopathies, Aneurysms, and certain Neoplasms (25%)
- c. Acute if the patient is symptomatic within 72 Hours
- d. Subacute if the time interval is 3-15 Days
- e. Chronic after two weeks
- f. Acute SDH is the commonest intracranial hematoma of Traumatic origin requiring surgical evacuation. A Lucid Interval is not infrequent
- g. Wide Craniotomy is indicated to drain the clot

and remove devitalized tissue

- h. Mortality approaches 50% and is mainly due to associated brain swelling, not responsive to therapy

5. Intracranial Hematoma

- a. Coup and Contracoup Injuries usually cause cerebral contusion and intracranial hemorrhage
- b. Prognosis is poor, but clot evacuation may be beneficial

IV. Resuscitation

- A. Although only about 20% of Head Injured patients require surgery, the Anesthesiologist is frequently called for Emergency Care
- B. Head Injury is a hyperdynamic process with a variable course which depends on the initial injury and on secondary brain damage
 - 1. Neuronal Injury is probably only Minimally Amenable to Treatment
 - 2. Therapy must be aimed at Prevention of Secondary Brain Damage and Provision of an Optimal Physiologic Environment to Maximize the Potential for Recovery
 - 3. Review of 116 Patients who Talked after Head Injury but Subsequently Died (a clinical situation encountered in 38% of Deaths), concluded that in

75%, one or more Avoidable Factors had occurred, and in over 50% these factors (Hypoxia, Hypotension, Delay in Treatment, Sepsis and Seizures) contributed to Death

C. Respiratory Care

1. Many laboratory studies have shown a High Incidence of Death (Up to 64%) due to Apnea after Head Injury
2. Neurogenic Pulmonary Edema and Hemorrhage have been demonstrated in 92% of Animals that Died and in 40% that Recovered after Unconsciousness Due to Severe Brain Trauma
3. Respiratory Complications are Prevented by Pre-Injury use of Sympatholytic Drugs, suggesting changes due to Central Factors causing release of Catecholamines
4. Absence of Spontaneous Ventilation on Admission to Hospital carries an Extremely Poor Prognosis unless the patient is seen within minutes Post Trauma when the Apnea may be part of Early Traumatic Unconsciousness. Finding applies also to Children
5. Transient Respiratory Arrest at the Time of Injury is not Uncommon and may cause diffuse Microatelectasis and Hypercarbia
6. Close correlation between the severity of Trauma (measured by the Glasgow Coma Scale) and the degree of Hypercarbia has been shown

- a. Scores below 9 were associated with PaCO₂ Levels over 50 mmHg
- b. Major Head Injuries and degree of Pulmonary Shunt Correlated directly with Outcome
- 7. Patients with Brain Stem Injuries may be Hypocarbic due to Neurogenic Hyperventilation
 - a. Respiration Work involved causes Hypoxia
 - b. Respiratory Alkalosis shifts the Oxygen Dissociation Curve to the Left making Oxygen less available to the tissues
- 8. Study of 1,845 Patients Admitted during a 28 Month Period identified 197 Patients:
 - a. Less Than 9 on the Glasgow Coma Scale
 - b. Survived 24 Hours
 - c. Had no other injuries
 - d. Times of Injury and Intubation recorded
 - e. The Adjusted Mortality Rate:
 - i. 22.5% in those Intubated within One Hour of Injury
 - ii. 38.4% in those in whom Intubation was Delayed for More than One Hour ($p < 0.01$)
 - f. Intubation and Administration of Supplemental Oxygen Indicated for Critically Injured Patients and it must be done Quickly
- 9. Securing the Airway
 - a. Sudden possibly catastrophic Increases in ICP

must be Prevented by

- i. Prior Hyperventilation
- ii. Administration of Intravenous Thiopental and/or Lidocaine, and a short acting Muscle Relaxant
- iii. Cricoid Pressure should be Used
- iv. Nasal Intubation is Not Indicated because of the Risk of Hemorrhage and Contamination if the patient has a Basal Skull Fracture

D. Cardiovasclar Stability

1. Cerebral Perfusion Pressure is Defined as follows:

$CPP = MABP - CVP \text{ (or ICP)}$

CPP = Cerebral Perfusion Pressure

MABP = Mean Arterial Blood Pressure

CVP = Central Venous Pressure

ICP = Intracranial Pressure

2. Maintenance of Adequate CPP (70-110 mmHg) is Essential to Avoid Brain Ischemia
3. Mechanical Regulation of CBF tested by Hemorrhagic Hypotenson (Classic Autoregulation) is Severely Impaired After Severe Injury
 - a. Slight Decrease in MABP may cause Severe Cerebral Ischemia that may be Irreversible despite Restoration of Systemic Blood Pressure and Volume

- b. Wounded Brain once Ischemic from Simultaneous Hemorrhagic Hypotension (i.e., Multiple Trauma) is at Risk for Reperfusion Failure
 - c. Clinical import of these observations are Clear: Systemic Blood Pressure and Volume Must be Maintained
- 3.
- a. Transient Hypotension not infrequent after Head Injury but Prolonged Decrease in Arterial Pressure in Adults indicates Extracranial Hemorrhage
 - b. In Children, because of Distensibility and Relative Large Size of the Head, Hypotension may occur on the basis Solely of an Intracranial Bleed
 - c. A Brain Stem Injury Severe enough to destroy the Vasomotor Center is Incompatible with Life
- 4.
- a. Hypertension and Tachycardia are the most frequently observed Hemodynamic Disorders following Head Injury
 - i. Heart Rates over 120 beats/minute reported in over one-third of patients and Systolic Blood Pressure of over 160 mmHg in one-fourth on admission to hospital
 - ii. Cerebral Vasomotor Paralysis or Impaired Autoregulation occurs frequently after

Head Injury

- iii. Hypertension in the Presence of those Abnormalities results in an Increase in Cerebral Edema and ICP which further Compromise the Injured Brain
- iv. Systemic Arterial Pressure more than 30% above Normal mean values should be Treated
- v. Prudent to Measure ICP to Ascertain Adequacy of CPP
- vi. Systemic Vasodilators such as Sodium Nitroprusside, Nitroglycerine and Hydralazine increase CBF and ICP and should be Avoided
- b. Hyperactive Sympathetic Nervous System exists in these patients, antihypertensive therapy should employ Adrenergic Blocking Agents
 - i. One Method is to infuse Propranolol (1 mg every 15 Minutes) until systolic pressure is less than 160 mmHg, diastolic pressure is below 90 mmHg, or the heart rate is less than 70 beats/minute
 - ii. Similar cardiovascular stabilizing effects and better preservation of Renal Perfusion with Tertatolol have been described

- c. Data concerning Cardiac Output after Head Injury are Conflicting, the Consensus is that both Cardiac Output and Cardiac Index are Increased. Outcome in young patients with decreased cardiac output is generally poor.

- 5.
 - a. ECG changes after Head Injury include
 - i. Increased Amplitude of P-Waves
 - ii. Prolonged Corrected QT Intervals
 - b. Findings following Subarachnoid Hemorrhage are probably due to Increased Sympathetic Tone and include
 - i. Tachycardia
 - ii. Prolonged QT Interval
 - iii. Large U-Waves,
 - iv. ST and T Wave Changes
 - v. Occurrence of Peaked P-Waves, Long PR Intervals, Prolonged QT Intervals and U Waves indicates a Poor Prognosis
 - v. Major Ventricular Extrasystoles and Heart Blocks are Rare
 - vi. Fatal Dysrhythmias have been Reported in Young Head Injured Patients Without Preexisting Cardiac Abnormalities
 - vii. Any Abnormality of the ECG in Patients with Subdural Hematoma has been

Associated with Increased Mortality

- c. ECG Abnormalities occurring early after Head Injury due primarily to combination of activation of Autonomic Nervous System (both Sympathetic and Parasympathetic) and Hypoxia.
- d. Therapeutic regimens to correct Hypoxia and increased Vagal Tone are well delineated (O₂ and Atropine)
 - i. Clinical experience with the use of Sympathetic Pharmacologic Blockage is encouraging

E. Blood Coagulopathies

- 1. Severe Brain Injury initiates the Outpouring of Tissue Thromboplastin and Activation of the Complement (C) System
- 2. Results in Disseminated Intravascular Coagulopathy Fibrinolysis Syndrome (DICF) and adds to Adult Respiratory Distress Syndrome (ARDS)
- 3. Occurs Immediately after Head Injury and reflects Continuing Brain Injury if the Coagulation Profile remains Abnormal
- 4. Outcome is Significantly Poorer
- 5. Recognition of Abnormal PT & PTT times in the Emergency Room
- 6. Prompt Therapy with Fresh Frozen Plasma, Cryoprecipitate, Whole Blood and, if necessary,

Platelets.

F. Control of Intracranial Pressure

1. More than Half of all Deaths from Head Trauma are associated with Increased ICP
2. Casual Role or Degree of Elevation and Outcome are Unclear
3. Hyperventilation causes Extracellular Alkalosis which Constricts Cerebral Resistance Arterioles
4. Systemic Blood Pressure transmitted to thin-walled Cerebral Vessels Decreases and Reduces Cerebral Blood Volume.
5. Effect of Hyperventilation on ICP begins in less than One Minute and stabilizes within 5 Minutes
6. During Continued Hyperventilation ICP slowly rises and becomes Stable after Three to Five Hours, usually at a Lower Level.
7. Hyperventilation, by Decreasing Blood Flow, may cause Ischemia
8. Ventilation, should be Titrated against Oxygen Content Differences Across the Brain
 - a. Measure Systemic Arterial Oxygen and Jugular Venous Bulb (JVB) Oxygen Content

$$CBF = \frac{AJDO_2}{CMRO_2}$$

AJDO₂ = Difference in Oxygen Content Between Arterial and Jugular Bulb Blood

CMRO₂ = Cerebral Metabolic Rate of Oxygen Consumption

- b. CMRO₂ correlates fairly accurately with the Glasgow Coma Scale which is a Predictor of Outcome after Head Injury
 - c. Normal Oxygen Content Differences across the Brain are 6-7 Vol Percent
 - d. Differences of 10 or More indicate Decreased CBF
 - e. Therapy should center on Increasing Flow and Reducing ICP by Diuresis. Values Below 6 Vol Percent (As is often seen Immediately after Injury and in Children) suggest that Raised ICP may safely be Treated by Hyperventilation
 - f. If Arterial Oxygen Saturation and Hemoglobin Levels are Normal, JVB Oxygen Tension of 26 mmHg is associated with Dizziness, and levels of 22 mmHg with Unconsciousness
 - g. Passive Hyperventilation may be adjusted to maintain JVB Oxygen Tension levels of 28-30 mmHg
9. Two Most Commonly used Dehydrating Agents are Mannitol and Furosemide
- a. Mannitol lacks a specific transport mechanisms and is excluded from the Brain by an intact Blood Brain Barrier (BBB)
 - b. Disrupted BBB permits its passage along a concentration gradient

- c. only parts of the brain not affected by the disease process are dehydrated
- d. Mannitol decreased Brain Water Content by Increasing Plasma Osmolarity and creating an Osmotic Gradient across the BBB
- e. A Triphasic Response to Rapid Administration of Mannitol Occurs
 - i. Transient (1-2 Min) period of Hypotension
 - ii. Increase in Blood Volume, Cardiac Index and Pulmonary Capillary Wedge Pressure. Intracranial Pressure May Increase Slightly as Cerebral Blood Volume and Flow Increases
 - iii. Within 30 Minutes, Blood Volume returns to Normal and other cardiac parameters fall slightly below baseline recordings
- f. The renal excretion of Mannitol requires free water. Sodium and potassium excretions are increased
- g. Mannitol decreases Blood Viscosity and thus increases Oxygen Delivery to the Brain which may cause Reflex Vasoconstriction
- h. Furosemide lowers ICP and brain Water Content alone and in combination with Mannitol
- i. Does not appear to Increase Blood Volume and may be Advantageous in patients with Cardiac

or Renal Disease

- j. Electrolyte balance is distributed less
- k. In large doses, Cerebrospinal Fluid formation is Reduced
- l. Furosemide prolongs Effectiveness of Mannitol by Sustaining the Increase in Serum Osmolality induced by the latter drug
- m. Administration of Mannitol 0.5/Kg followed after 15 minutes by Furosemide 0.5 Hg/Kg causes prompt and usually adequate brain shrinkage
 - i. Fluid and Electrolyte Losses are Increased
 - ii. Peak Loss of Sodium increases 5-Fold
 - iii. Water Excretion up to 42 ml/min has been reported with this combination use as compared to 17 ml/min with Mannitol alone
- n.
 - i. No advantages of High dose Dexamethasone on ICP Trends or Clinical Outcome in the treatment of Severe Head Injury have been demonstrated
 - ii. Steroid Administration potentiates an already accelerated Post-Traumatic Catabolic Response
 - iii. Increases Urinary Sodium losses (Hyponatremia Increases ICP)

iv. Causes Hyperglycemia (Hyperglycemia Increases the Size of an Infarct in Hypoxic Neural Tissue and has been associated with Acute Elevation of ICP)

V. Neurodiagnostic Testing

- A. Increased ICP, Hypoxia and Hypercapnia cause patients to become Restless, Agitated, or Belligerent, often making Neurodiagnostic Studies difficult or the results equivocal
- B. Cooperation especially difficult to obtain from Young Children
- C.
 - 1. Patients should be Sedated only after the Cause of their Restlessness has been Established and appropriate therapy initiated
 - 2. If any doubt as to the adequacy of the Airway, a general endotracheal anesthetic technique is indicated
- D. Reduction of PaCO₂ levels may, by decreasing CBF, allow better Angiographic Studies
- E.
 - 1. Introduction of Computerized Transaxial Tomography has greatly facilitated Neuroradiologic Diagnosis
 - 2. Serial Computed Tomography is an aid in predicting Outcome of patients with Severe Head Injury
 - 3. New Findings after the Initial Study are Associated with Poorer Outcome

VI. Intraoperative Management

A. Key Aims:

- 1. Maintenance of an Impeccable Airway**
- 2. Cardiovascular Stability**
- 3. Optimizing of Intracranial Dynamics**

B. Preoperative Medication is Rarely Indicated:

- 1. Pain is not a major complaint**
- 2. Respiratory, Cardiac and Neurologic Depression Must be Avoided**

C. Monitoring

- 1. Continuous ECG Recording**
- 2. Pulse Oximetry**
- 3. Arterial Cannulation**
- 4. Fluid Balance**
- 5. Doppler Ultrasound, (to detect Air Embolism)**
- 6. End Tidal CO₂**
- 7. Temperature**
- 8. a. A Flow Directed Balloon Flotation Catheter may be Extremely Valuable in determining Fluid Requirements especially in cases of High Cord Injury**
 - b. Surgery should Rarely be Delayed pending Insertion**
 - c. Should Pulmonary Artery Rupture occur or if the Head is Placed either Down or Laterally, further Cerebral Injury may Result**

D. Anesthetic Technique

1. Intubation accomplished as expeditiously as possible using Small Incremental Doses of Sodium Thiopental, Atracurium or Vecuronium, Lidocaine (intravenously and topically) and Labetolol (as indicated by systemic hypertension) with Cricoid Pressure
2. Hyperkalemia may be induced by Succinylcholine in a Closed Head Injury patient without Paresis and therefore this drug should be Avoided
3. Blood Loss and Diuretic Therapy cause Hypovolemia, but this state may not initially cause Hypotension because the victim generally has a healthy vasculature which compensates
4. Intracranial Damage is usually associated with Hypertension. The true state of Hydration may be realized for the first time following Induction when Catastrophic Hypotension may occur if Fluid Replacement is Inadequate or Barbiturate Dosage Excessive
5. Anesthetic Technique depends on the Pathophysiology
 - a. Hyperemic States (i.e., narrow A-J D02) commonly seen Immediately after Injury and in small Children may be better managed with a Barbiturate, Narcotic, Hyperventilation Technique

- b. Ischemic Situations (i.e., wide A-J DO₂) as occurs after Blunt Trauma respond better to Drugs that maintain Perfusion and Reduce Metabolic Requirements (i.e., Light Inhalational Anesthesia)
 - c. Nitrous Oxide should be Avoided both because of Adverse Increases in Flow and Metabolism and the Risk of increasing the size of a Trapped Air Mass
- 6.
- a. Fluid Replacement should be with Non-Glucose containing solutions
 - b. Administration of Glucose in Hypoxic or Ischemic situations Exacerbates Brain Damage and Increases the Size of an Infarcted Area
 - c. Cerebral Edema is probably not Decreased by Establishment of a Negative Fluid Balance
 - d. Hypovolemia May Cause Hypotension, an Unstable Anesthetic course and, by Decreasing Cerebral Oxygen Delivery, Increase Cerebral Vasodilation
 - e. Rheologic conditions are Optimal at Hematocrit Levels of 30-32%

E. Emergence

- 1. If patient conscious preoperatively, the same state should be realized within minutes of the end of surgery

2. With the release of an intracranial mass lesion,
many patients regain consciousness promptly

VII. Summary

**MEASUREMENT OF BRAIN TISSUE OXYGENATION BY NEAR-INFRARED
SPECTROSCOPY**

Kazuo Okada, M.D., Ph.D.

I. Introduction

A. Development of Tissue Oxygenation Measurement

II. Blood Flow Distribution

A. Hypoxia

B. Shock

III. Tissue Oxygen Measurement

A. Purpose

B. Tissue Oxygen Tension Measurement

C. Conjunctival Oxygen Tension Measurement

IV. Principles of Near Infrared Spectroscopy

A. Algorithm of Near-Infrared Spectrum Analysis

B. Multi-Wave Length Method

C. Respiratory Chain and Cytochrome Oxidase

D. Separation of HB, HB02, and Cytochrome Oxidase Signals

V. Experimental Data

A. Brain Ischemia

B. Hypoxia

C. Hypo- and Hypercarbia

D. Hypoglycemia

VI. Clinical Data

A. Monitoring During Extracorporeal Circulation and
Hypothermia

VII. Conclusions

HEMOGLOBINOPATHIES

Michael E. Bearb, M.D.

I. Introduction

- A. Overview**
- B. Physiology of Hemoglobin**

II. Sickle Cell Syndrome

- A. Overview**
- B. Sickle Cell Trait**
- C. Sickle Cell Disease**
- D. Pathophysiology**
- E. Clinical Manifestations**
 - 1. Hematologic**
 - 2. Immune**
 - 3. Pulmonary**
 - 4. Cardiac**
 - 5. Renal**
 - 6. Neurologic**
 - 7. Other**
 - 8. Sickle Cell Crisis**
- F. Mortality**
- G. Diagnosis**
 - 1. Peripheral Blood Smear**
 - 2. Sodium Metabisulfite Test**
 - 3. Solubility Test**

4. Hemoglobin Electrophoresis

H. Treatment

1. Supportive Measures

2. Newer Modalities

I. Management of Anesthesia

1. Anesthetic Technique

2. Perioperative Considerations

3. Preoperative Transfusion Therapy

a. Need for Preoperative Transfusion

b. Goals for Preoperative Transfusion

c. Transfusion Regimen

4. Intraoperative Management

5. Postoperative Management

III. Thalessemias

A. Introduction

B. Alpha Thalassemia

1. Overview

2. Classification of Alpha Thalassemias

a. Silent Carrier

b. Alpha Thalassemia Trait

c. Hemoglobin H Disease

d. Hemizygous Alpha Thalassemia

C. Beta Thalassemia

1. Overview

2. Classification of Beta Thalassemia

- a. Beta Thalassemia Minor
- b. Beta Thalassemia Intermedia
- c. Beta Thalassemia Major

D. Clinical Manifestation

- 1. Untreated Hypotransfused Patient
- 2. Appropriately Transfused Patient with Secondary Hemochromatosis
 - a. Cardiac
 - b. Hepatic
 - c. Endocrine
 - d. Pulmonary
 - e. Immune

E. Mortality

F. Diagnosis

G. Treatment

- 1. Transfusion Therapy
- 2. Treatment of Secondary Hemochromatosis
- 3. Newer Therapies

H. Anesthetic Management

- 1. Anesthetic Technique
- 2. Preoperative Management
- 3. Intraoperative Management
- 4. Postoperative Management
- 5. Hemoglobin H Disease

**COMPLICATIONS OF TRAUMA AND TRAUMA ANESTHESIA; BLEEDING AND
THROMBOSIS**

Charles W. Whitten, M.D.

I. Introduction

II. Normal Hemostasis

III. Overview of the Coagulation Mechanism

A. Primary Hemostasis

- 1. Platelet Adhesion**
- 2. Platelet Aggregation**

B. Secondary Hemostasis

C. Fibrinolysis

IV. Evaluation of Hemostasis in Trauma Patients

A. Preoperative Factors

- 1. Liver Dysfunction**
- 2. Ingestion of Aspirin or Nonsteroidal Anti-Inflammatory Compounds**

B. Laboratory Evaluation

- 1. Bleeding Time**
- 2. Prothrombin Time**
- 3. Activated Partial Thromboplastin Time**
- 4. Thrombin Time**
- 5. Activated Clotting Time**

6. Thromboelastography

V. Pharmacologic Treatment Modalities

A. DDAVP

B. Anti-Fibrinolytics (Aprotinin, Epsilon Aminocaproic Acid, Tranexamic Acid)

VI. Summary

CARDIOVASCULAR COMPLICATIONS FOLLOWING TRAUMATIC INJURY

Philip D. Lumb, M.B., B.S.

I. Thoracic

A. Cardiac

- 1. Penetrating**
- 2. Blunt**
 - a. Contusion/Concussion**
 - b. Valvular Injury**
- 3. Tamponade**

B. Diaphragmatic Rupture

C. Pulmonary

- 1. Pneumothorax/Hemothorax**
- 2. Contusion**
- 3. Hemorrhage**

D. Major Vessels

- 1. Aortic Transection**
 - a. Ascending**
 - b. Descending**
- 2. Pulmonary Artery**
- 3. Other**

II. Abdominal

A. Hollow Organ Damage

- 1. Stomach**
- 2. GI Tract**

B. Solid Organ Damage

1. Liver
2. Spleen
3. Kidney

III. Extremity

A. Hemorrhage

1. Concealed
2. Revealed

B. Tissue Damage

1. Activation of Local Nociceptors
2. Suppression of Baroreflex Sensitivity

IV. Central Nervous System

A. Head injuries

1. Resuscitation Priorities
2. Associated Injuries

B. Spinal Cord injuries

1. Early vs. Late Changes
2. Anesthetic and Critical Care Implications

C. Peripheral Nerve Injuries

1. Primary Damage
2. Entrapment (Compartment Syndromes)

V. Diagnosis

A. Physical Examination

1. Trauma Assessment
2. Secondary Examinations

B. Special Investigations

1. Radiology
2. Electrocardiogram
3. Echocardiogram
4. Chemistries

VI. Therapeutic Options

A. Resuscitation

1. Airway
2. Breathing
3. Circulation

B. Fluid Management Protocols

1. Crystalloid
2. Colloid
3. "Goal Oriented" Fluid Management
 - a. Oxygen Delivery Parameters
 - b. Hemodynamic Parameters
 - c. Perfusion Characteristics

C. Mechanical Ventilation

1. Available Modes
2. PEEP?

D. Analgesia

1. Regional
2. Systemic

E. Mediator Modulation

- 1. Local Analgesic Options**
- 2. The "Lytic Cocktail" Revisted**

PULMONARY COMPLICATIONS OF SEVERE TRAUMA

Anne J. Sutcliffe, FFARCS

I. Introduction

- A. Primary Pulmonary Trauma**
- B. Sepsis**
- C. Adult Respiratory Distress Syndrome (ARDS)**
- D. Fat Embolism Syndrome (FES)**

II. Pathophysiology of Pulmonary Contusion

- A. Parenchymal Lung Damage**
 - 1. Edema**
 - 2. Hemorrhage**
 - 3. Atelectasis**

III. Resolution of Pulmonary Contusion

- A. Edema is Worsened by Fluid Overload**
- B. Edema Predisposes to Pulmonary Sepsis**
- C. Pulmonary Sepsis Can Cause ARDS**
- D. Resolution is Delayed by Overload and Sepsis**

IV. Management of Pulmonary Contusion

- A. Maintain Tissue Oxygenation**
- B. Minimize Atelectasis/Promote Lung Expansion**

V. Management of Pulmonary Contusion

- A. Oxygen Therapy
- B. Restore Circulating Blood Volume
- C. Avoid Fluid Overload
- D. (?) Albumin, Diuretics, Steroids
- E. Drain Blood and Air
- F. Physiotherapy/Breathing Exercises
- G. Mobilize
- H. Analgesia
- I. Night Sedation
- J. Nutrition

VI. Factors Predisposing to Infection

- A. Hypovolemia +/- Trauma ("Toxins")
- B. Fluid Overload
- C. Pain
- D. Immobility
- E. Starvation

VII. Factors Predisposing to ARDS

- A. Hypovolemia/Trauma "Toxins"
- B. Fluid Overload
- C. Pulmonary Contusion
- D. Fat Embolism Syndrome (FES)
- E. Sepsis

VIII. Incidence of FES Related to Management of Long Bone and Pelvic Fractures

IX. Incidence of FES in All Patients with Major Trauma

X. Incidence of FES and Conservative Management

XI. Incidence of FES Related to Fracture Management

XII. Mortality Related to Fixation of Fractures

XIII. Pulmonary Dysfunction Related to Fracture Management

XIV. Mortality and ARDS Related to Early Fixation of Fractures in Ventilated Patients

XV. Significant Effects of Early Fracture Fixation

XVI. Birmingham Accident Hospital and Fracture Management

XVII. Does Early Fixation of Fractures Really Reduce the Incidence of Pulmonary Complications and Mortality in All Situations?

XVIII. Advantages of Early Fracture Fixation

XIX. Disadvantages of Early Fracture Fixation

- A. Prolonged Anesthesia
- B. Failure to Diagnose Other Injuries
- C. Hypothermia
- D. Acute Blood Loss

XX. Potential Advantage of Surgery (i.e., Anesthesia)

- A. Meticulous Preoperative Resuscitation
- B. An Anesthetic Approach to Hypoxia and Hypovolemia
- C. Meticulous Monitoring

XXI. Evidence for the Benefits of Anesthesia

XXII. Conclusion

- A. Early Fixation of Fractures May Reduce the Incidence of Post Traumatic Pulmonary Dysfunction
- B. The Surgical Procedure May Not be the Key Factor Which Produces this Effect

**WHEN YOUR TRAUMA PATIENT DIES: FAILED RESUSCITATION, BRAIN
DEATH, ORGAN SALVAGE AND TRANSPLANTATION**

Ake N.A. Grenvik, M.D., Ph.D.

I. Historical Perspective

- A. Traditionally, the Majority of Brain Dead (BD) Organ Donors have been patients with Lethal Head Injuries**
- B. The Main Cause of such Brain Trauma used to be Motor Vehicle Accidents (MVA)**
 - 1. Annual Number of Patients Dying from Severe MVA's in recent years has Decreased from 50,000 to 40,000, i.e. by approximately 20%**
 - 2. With increased use of Air Bags, this tendency is expected to continue**
 - 3. Number of Patients Dying From Gunshot Wounds is Increasing**
 - a. Many are Head Injuries which may keep the annual number of patients developing Brain Death from Head Trauma on the same level as before**
 - b. Therefore, Trauma Centers are expected to continue as the Main Suppliers of BD, Heart-Beating Organ Donors with commonly performed Organ Essential Procurement in the OR of these Centers**

1. Essential that the Trauma Anesthesiologists be familiar with the Clinical, Ethical and Legal Aspects of Organ Donation and Procurement from BD Patients
2. Also have reasonable understanding of the Transplantation Organization

II. Organizational Perspectives

A. Since 1987, all transplantation activity in the US is coordinated by the United Network for Organ Sharing (UNOS)

1. In 1992, there were over 16,000 Organ Transplants performed
2. Vast Majority of these Organs came from BD Donors, which remain the Best and Most Logical Source of Organs
3. Unexpected Success of modern transplantation has yielded One Year Graft Survival of 80-90% (Not only for Kidneys but also Hearts and Livers with results of Pancreas and Lungs not yet equally great).
4. In Single, End-Stage Organ Failure, Transplantation is now the Preferred Form of Therapy.
5. Of the Estimated 12,000 to 15,000 BD patients each year, only little more than 4,000 eventually end up as Organ Donors
6. With UNOS List of Waiting Candidates now surpassing

30,000, 6-7 potential recipients Die Each Day without the second chance for life that a transplantation means.

7. Rapidly increasing Waitlist has resulted in a Crisis

- a. Trauma Centers are encouraged to do utmost in helping not only to Identify all Potential Organ Donors
- b. Also Optimally Manage these unfortunate patients both Before and After Death
- c. Thus, provide the best possible Organs for those desperate, about-to-die candidates, whose only possibility for continued life is another organ

III. Current Approaches

A. Demand for Organs by far outpacing Current Supply

- 1. Transplant Centers are Reintroducing Non-Heart-Beating Cadevers as Donors.
 - a. Necessitates Emergency Procurement immediately after death from Irreversible Cardiac Arrest.
 - b. May be relatively Young Trauma Victims, who in spite of all efforts proceed to die.
 - c. Their management is an even greater challenge to the Trauma Anesthesiologist, Surgeon and Intensivist.

2. Improved technique for In Situ Cooling to preserve organs by protection from warm ischemia is an emergency need
 - a. This Technique cannot be used until the patient is Certified Dead
 - b. In this situation ethicists once more argue about the True Moment of Death, which must precede organ procurement
3. Expectations of Correct Performance of the Trauma Team during and after death of the victim are increasingly Complex.
 - a. Thorough knowledge is extremely important to avoid confusion and medicolegal problems on the one hand, and provide best possible organs to the many waiting recipients on the other

IV. Conclusion

- A. Through multiple organ procurement one donor can provide an opportunity for continued life of 6-8 recipients with otherwise extremely limited survival time